ROADS AND STREETS

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How Better Highway Facilities Reduce Accidents

Based on past experience 1 out of every 1,000 automobiles will be involved in a fatal accident during the next year. At this rate, if the average owner were to drive a car for 50 years, there would be 1 fatal accident for every 20 car owners during their 50 years of motoring.

It is true that two-thirds of the fatalities are among pedestrians; but the danger that the drivers and passengers incur is very great when during every year 1 out of every 3,000 is doomed to die, so long as present conditions remain unimproved.

In the early days of American railroading the accident rate was very high. But improved machinery, better management and growing caution have made travelling by rail so safe that we have ceased to regard it as being at all hazardous. Perhaps travelling by motor car will never become as safe as by rail, but it is reasonably sure that its present risk will be greatly reduced. Not the least of the means by which safety on our highways has been increased is the improvement in our highways themselves. Thus far these improvements that have had most to do with reducing hazards have been the paving and widening of roads. A narrow earth road, particularly where deep ditches or high embankments exist, is an exceedingly dangerous highway over which to travel at speeds exceeding 25 miles an hour. A little mud after a rain, or even a little loose gravel has caused many a fatal skidding. Then there is the ever present risk of a collision or of being crowded off the road. So the first important step in reducing accidents is to provide a roadway fully 20 ft. wide and to keep it as dry and clean as practicable.

The next step is to pave the roadway and to divide it into two or more traffic lanes clearly marked on its surface. This means that the pavement should have only a slight crown, for the vehicles should be encouraged to stick to their lanes. There is a tendency to crowd toward the center of a road if its crown is very distinguishable to the person driving a car.

Traffic signals on roads and streets seem destined to promote highway safety fully as much as they have promoted railway safety. Block-signalling was of inestimable value in reducing railway accidents. Stop and go signals and wig-wags at railway crossings will undoubtedly do for highways what block-signalling did for railways.

Widening, paving, traffic-laning, signalling—these are the four great means by which the highway engineer can best promote safety on our roads and streets. But this all calls for money in no niggardly sums; and the needed money can be raised only by making the public see that it pays to secure greater safety in this manner. A false sense of forthcoming security as a result of passing more stringent road laws, or as a consequence of public education in carefulness, may lead the public to postpone adequate widening, paving and signalling.

The average careless driver will always remain careless. This, at any rate, has been the experience of street-car companies with careless motormen; they never reform. Hence educational campaigns to secure greater carefulness at best will be very inadequate.

As for road laws, we have had them in superabundance for 30 years, and they have accomplished very little in promoting safety. About half the population will have to be hired as traffic-cops to watch the other half if general obedience to road laws is to be secured; and then the traffic-cops themselves will break all speed laws, just as they do now. Accident reduction by police activity has been a failure, except in very congested areas.

Why States Should Build Pavements Through Towns

Bottle-neck streets and poor pavements characterize many of the main thoroughfares of cities and towns. A fine, modern state highway often enters a city only to be greeted at the very threshold by a bumpy, beggarly roadway. When the reason for such a greeting is sought, it usually is that the abutting property owners have refused to be assessed for widening and properly paving the street. Nor can you always blame them, for why should they be asked to stand the entire cost of an improvement that is far in excess of their own personal needs? With almost equal justice might a farmer be required to pay the entire cost of a four-track railway through his farm.

This being the condition that confronts us in almost every town, we should set about finding a remedy that will promptly change the condition. For many years we have editorially advocated one remedy, namely, that the city at large pay most of the cost of improving all streets that serve as highways for through traffic. But there are some 10,000 incorporated towns and cities in America, and many officials and voters in each that must first be persuaded to change present assessment practices before this problem can be solved along the lines that we have hitherto advocated. Consideration of the magnitude of this inertia leads us to change our solution of the problem.

Wherever a state highway system exists, let the state build and maintain that part of it that extends through a city or town.

It should not be difficult to secure amendment of laws so as to enable a state to extend its highways through cities and towns, whereas it seems to be impracticable to get cities and towns to amend their street assessment ordinances. Much the same sort of difficulty faces us here as faced the early advocates of better country

roads. When the cost of roadwork was entirely borne by the farmers, ours was a country of mud or dust highways. The state-aid plan has largely altered that condition. We advocate the universal extension of that same plan to city and town streets that are arteries of through traffic.

The congestion on many such streets is so bad that traffic is greatly impeded. Even worse, perhaps, are the deaths and maimings that exist where bottle-neck streets cause road-hogging to display itself in its most aggravated form. But there is little need of complaining about a condition that excites complaints from every one. The real need is to diagnose the cause of the disease and to apply the remedy.

"Researchers Are the Poets of Today"

Workers in physical research were hailed as "the poets of today" by Owen D. Young, chairman of the board of the General Electric Company, in addressing the 64th annual convocation of the University of the State of New York.

He drew a parallel between two periods of 75 years each, the one from 1575 to 1650, the other from 1875 to 1950, both of which he called the most productive in the history of man. As the voyages of Vasco da Gama, Columbus and Magellan ushered in the Elizabethan age of poetry, so the discoveries of Dalton, Prout, Crookes and Roentgen "disclosed another and even more marvelous universe within the atom, for an explanation of which we look to the physical scientist of today." In both periods glimpses of new realms caught the eye, and the unique visions fired the imagination of mankind.

Mr. Young's peroration is splendid:

"I salute the workers in physical research as the poets of today. They appeal to the imagination of us all. They contribute the warming glow of inspiration to industry, and when industry pulls their ideas down from the heavens to the earth and harnesses them for practical service it too feels that it is an important actor, not only in the making of things, but on the larger stage of human spirit. There may be enough poetry in the whir of our machines so that our machine age will become immortal."

It should be remembered that the author of this tribute to research scientists speaks from an intimate knowledge of the value of research, for the General Electric Company has for years maintained one of the finest and most successful research laboratories in the world.

Perhaps the greatest discovery of the 20th century is the discovery that an inventing device can be invented; for what, after all, are modern research laboratories if they are not just that? Behold them bringing together a group of scientists and engineers, and so organizing their efforts that with relative speed the most difficult of scientific problems are solved.

Fourteen years ago we heralded in these columns the achievement of transcontinental telephony by the research engineers of the American Telephone and Telegraph Co. We showed a photograph of the composite inventor credited with this achievement. At that time the idea of inventing an inventor was relatively new, and there were few research groups of co-operating scientists in America. There are now a thousand or more research laboratories, and their number steadily increases.

Within the last two decades organized physical research has grown from infancy to vigorous youth, and now approaches maturity. The number of executives who fully appreciate the power of research, as does Owen D. Young, is still relatively small. But when voices such as his are raised in praise of organized research, we may safely predict that before 1950 physical research laboratories will have become at least as numerous as the large industrial companies.

The verbal poetry of the Elizabethan period reached its climax of beauty in Shakespeare's blank verse. The physical poetry that Mr. Young extols will have its Shakespeares, too, but their deaths will herald the birth of successors equally great, in sequence unending.

The Hazard of Flying

Will Rogers may be unintentionally accountable for a good many deaths because of his reiterated comments on the safety of aviation. Twice recently he has complained when newspapers front-paged the deaths of six or more fliers in a single day. Will has twice made the remark that no such front-page space was given to deaths from drinking poison whiskey, or from automobiling.

Argument of that sort, if argument it be, is fallacious unless we are told how many people are drinking liquor or how many are automobiling, and of those numbers how many fatalities occur annually. We can't qualify on "hootch" statistics, but we do know that for every 3,000 automobiles one driver or passenger meets death in an automobile accident during a year. We read the other day that there are fewer than 3,000 licensed airplane pilots in America. Hence if only one death occurred among them and their passengers during a year, the fatality risk to those engaged in flying would be about on a parity with the fatality risk to those engaged in automobiling.

Statistics of deaths by airplane accidents for 1928 will soon be available, but even without them the memory of any reader of the daily papers will serve to tell him that dozens of such deaths have occurred already during this year.

Flying is becoming relatively safer each year, and there may be conditions even now under which a person may assume the risk of flying without undue worry; but we contend that no man's "hunch" as to the safety of flying is worth a moment's consideration. Because a plane has three motors, looks safe and is in the hands of an experienced pilot, there are many men who go no further in their search for evidence as to its safety. Of such is the kingdom of "hunchers."

Nothing is to be gained by belittling the risk of flying. Quite the contrary. It is only by recognizing the great hazard in flying that flying will be made relatively safe within the next generation or sooner.

W. P. Gillette

Two Outfits Working on County Widening Job

Methods and Equipment Used on River Road, Cook County, Ill.

COOK COUNTY, ILLINOIS, is widening the DesPlaines River Road, one of the main north-south highways west of Chicago and noted for the fact that along its edge lies miles of the county Forest Preserve park system on the banks of the DesPlaines River, as well as for the fact that it intercepts many of the main highways leading out of the city and affords a connecting link between many suburban communities. Up to the present time this highway has been paved with a 20-ft. concrete pavement, with wide shoulders, but that pavement has proven no longer capable of carrying the heavy traffic that uses the highway. Widening was therefore decided upon, and a second 20-ft. strip is now being paved alongside the original pavement. This new strip is of the standard Illinois section, 9 in. thick at the edges and thinning to 7 in. within 3 ft. of the edge and a uniform thickness of 9 in. for the first foot from the edge and the thinning taking place within the second two feet. A metal center joint separates the 20-ft. strip into two sections each 10 ft. wide. The length under construction is about 9½ miles.

Grading.—Heavy grading was done with two ¾-yd. Koehring power shovels, loading into motor trucks, while some grading was done with an Adams Leaning Wheel Grader No. 12, hauled by a Caterpillar 60 tractor, and with a W. A. Riddell Ronning "International" H-P one man grader, powered with a McCormick-Deering tractor. The subgrade was rolled with an Austin Pup. When the work was visited, the Adams grader was found working a bad mudhole so as to hasten drying. The day was rather cold, about ten degrees above freezing, and excessive rain had left the subgrade in bad shape. By reworking the mud and mixing with it some dry material from the subgrade, it was hoped that some time would thus be saved and the concrete could be

Construction Operations on the Widening of the Des Plaines River Road in Cook County, Illinois

laid over this section earlier than would otherwise have been possible.

Two Paving Outfits.—Due to the extent of the job and the fact that the contractor who was awarded the work had only one paving outfit that could be released from other work at the time the equipment was needed, in the face of the situation that the season was well advanced and that early completion of the work before winter required the use of two paving outfits, the contractor sublet half of the work to another concern, and put one paver to work on his half, while the subcontractor also brought in a paver on his own half. Thus two outfits were working on the job, in the attempt to have the pavement open to traffic by snowfall, throughout its entire length, one working toward each end of the job. Specifications called for a 1:2:3½ concrete, with 9 bags of cement to the batch at intersections, and enough water to just allow finishing with the perforated roller. The part of the work being done by the subcontractor was visited, but description of that part of the work will serve to illustrate as well the work done by the other outfit.

Material Supply.—Materials, in batches, were delivered to the paver by a hauling contractor working with a material firm, under contract, on the basis of the contractor paying for the materials delivered at the paver. To serve the job, the material firm set up a batching outfit conveniently located with respect to the center of the job. Aggregates and cement were delivered to this site by rail, at a team track. Aggregates were unloaded from cars into stock piles or into a Johnson bin equipped with measuring hoppers, or from the stock piles into the bin, by means of a Moore Speedcrane, equipped with a 1 cu. yd. clamshell bucket. Cement, in sacks, was delivered to the team track in box cars, spotted alongside the bins, and the sacks were opened and the cement dumped into the trucks directly from the car. Seven 3-batch Autocar motor trucks were used to take the materials from the plant to the paver. The maximum haul was about 1½ miles.

Materials Gang.—Aside from the man in charge, the materials outfit required the services of one crane operator, one man loading sand and stone, three men in the cement car, one man in the truck empting cement from the sacks, and a car cleaner.

The Paver.—The paver used on this work was a 27-E Koehring. The trucks dumped the batches into the charging skip, and the concrete was mixed one minute and placed on the subgrade in the usual manner. Finishing was done after spading by means of a perforated roller and a length of rubber hose, plus the usual finishing tools. After finishing, a layer of straw was spread on the surface and left in place for a period of from one day to two weeks, as directed by the engineer.

Paving Gang.—Before concrete was placed, 10 men were used putting the subgrade in shape. Forms were set by one form setter and one helper, one operator served the paver, then there were three spaders, two men on the roller, two tampers, one man on curing, and two finishers.

With this equipment and organization, the contractor has been averaging about 1,400 sq. yd. of pavement per day, the length of which has varied from 8 to 10 hours, depending upon conditions. A great deal of bad weather has been encountered, and this has had its effect on the job, since the subgrade is of clay, and batches have to be hauled over the subgrade.

Those Responsible.—The work is being done for the county under the direction of Maj. George A. Quinlan, Superintendent of Highways, and W. E. Bates, engineer of construction, who were represented on the work by C. K. Creelman, resident engineer. The general contract was awarded to Jaques Bros., who sublet part to the Iroquois Const. Co., represented, on the work described, by Day Okes, vice-president, and J. J. Taafe, superintendent. Materials were furnished by the Materials Service Corporation, and hauling was done by the Worth Motor Service.

"The Lowest Responsible Bidder"

Rulings of North Dakota Supreme Court Cited in North Dakota Highway Bulletin.

Chapter 159 of the Laws of 1927, like previous similar statutes, provides that the State Highway Commission shall award contracts to "the lowest responsible bidder." It is the common impression among many people that this phrase means the lowest bidder irrespective of financial ability, so long as he can secure a bond, nor his other qualifications to handle a given job, such as road-building experience, equipment and general fitness.

The Supreme Court of North Dakota, however, in two cases has laid down a judicial interpretation of the meaning of the phrase "the lowest responsible bidder." The test pronouncement of the court was made on March 15, 1927, and the opinion of the court written by Chief Justice Christianson. It is found in Volume 212, on page 773 of the Northwestern Reporter. The facts in the case show that a contract was awarded for the repair and improvement of a schoolhouse and that the board in question did not award such contract to the lowest bidder, but to another contractor whom it regarded as more responsible. Nevertheless, the ruling of the court applies in the matter of highway contracts because the language in both statutes is identical. The syllabus of the court in this case reads as follows:

"The board of a common school district has power to contract for the remodeling of an existing schoolhouse so as to provide for the heating of the schoolhouse, for a sufficient water supply, and for necessary toilet facilities, without submitting such propositions to a vote of the electors of the district.

"The word 'responsible,' in the phrase 'lowest responsible bidder,' in section 1356, which provides that 'no contract except for teacher's salary, professional services, janitor's wages, or school textbooks involving the expenditure of school funds or money appropriated for any purpose relating to the educational system of this state, or any county, district or school corporation therein, when the amount exceeds one hundred dollars, shall be let until proposals are advertised for a period of ten days, and after such advertisement, only to the lowest responsible bidder, * * *" means something more than mere financial responsibility. It means responsibility as regards the duty to be assumed by the contractor under the particular contract, and includes all the various elements that bear on that question, such as the integrity of the bidder, his skill, ability, and capacity to perform the particular work. "The board of directors of a common school district, in considering bids for a contract submitted under this statute, must determine which one of several bidders presenting bids for a contract is the lowest responsible bidder, and such determination cannot ordinarily be set aside by a court, unless the action of the board is arbitrary or fraudulent."

While the court in its opinion did not cite or reaffirm its decision in an earlier case involving a similar question, it came to the same conclusion. The earlier case is Chaffee vs. Crowley, found in Volume 49 on page 111 of the North Dakota Reports and deals with a contract involving repairs on a courthouse. The language is similar to that found in the highway laws relative to awarding contracts to the "lowest responsible bidder." The opinion was written by Justice Bronson and the pertinent portion thereof reads as follows:

"Concerning such contracts, the law provides that the lowest responsible bid must, in all cases be accepted. Chap. 49, Laws of 1921. It is well recognized that a responsible bid involves the elements of the ability, capacity, reputation, experience and efficiency of the bidders. Responsibility must be determined as well as the pecuniary amount. 36 Cyc. 876; Butler vs. Darst, 38 L. R. A. (N. S.) 655, note. The county commissioners have a discretion to exercise in this regard. 15 C. J. 551; 7 R. C. L. 943; 1 Abbott, Mun. Corp. P. 268. There is no showing that they did not exercise their best judgment within the discretion they possessed in selecting the lowest responsible bidder; nor that they acted in bad faith or other than for the best interests of the county. In their judgment the small difference in dollars between the bids offered might be far outweighed by the ability, efficiency, and facilities of contractor to whom award was made."

Earth Road Construction in Western Canada

Recent Practice in the Province of Saskatchewan

By H. R. MacKENZIE

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EARTH roads still constitute a very large proportion of our Canadian highway transportation system. In Western Canada, the present relation of population to road mileage makes it impossible for us to finance the construction of any material mileage of hard-surfaced roads in the rural districts. We are placing gravel surfacing on our highways as speedily as possible, but we still have a large mileage of roads on our provincial highway system which will have to be constructed and maintained as earth roads pending the completion of our gravel-surfacing program, and the larger portion of our secondary system of roads is destined to remain as earth roads for some considerable period. In Eastern Canada also there still remains a very large mileage of earth roads, consequently their construction and maintenance is a subject which must continue to interest the members of the Canadian Good Roads Association.

Provincial Highway System.—There are approximately 200,000 miles of road allowances in the settled area of the province of Saskatchewan. Our provincial highway system comprises 7,300 miles, and during the past 8 years we have constructed, under engineering supervision, approximately 3,400 miles of earth road on our provincial highway system. We are steadily raising our standard, and we find it necessary to revise our specifications and our instructions to our field engineers, in order that we may put into pratcical use the information, which we have obtained by observing the difficulties encountered in maintaining roads built to our obsolete standards; and in order that we may provide for the requirements of an ever-increasing volume of motor traffic, travelling at an increased speed.

It is extremely difficult to anticipate future traffic requirements, but we are endeavoring to so locate and construct our earth roads that they will have to be altered as little as possible when constructing the higher-type roads that the future will demand, and I shall now endeavor to briefly outline what I consider to be the most important recent improvements in the methods of constructing earth roads. My remarks will apply particularly to the province of Saskatchewan, but I believe that the type of earth roads being constructed in each of the three prairie provinces is very similar in design and is being constructed at practically the same cost per mile.

Location Work.—We have found it preferable to have preliminary profiles taken by location parties, rather than by the resident engineers on construction, as more uniformity is secured in the matter of determining the heights of embankments and the required capacity of drainage structures. Uniformity in the method of recording all field data simplifies office design, and is more easily obtained when a few men have made all the surveys.

During the past two years the greatest changes in our location work have been in the matters of alignment and sight line. We endeavor, wherever practicable, to secure a clear sight-line of 500 ft. on both vertical and horizontal curves. We have adopted a 16° curve as the sharpest curve to be used on our provincial highways, and this curve is now being constructed at all right-angled turns. On all other road diversions the maximum degree of curvature is avoided wherever the topography will permit. I consider that the providing of easy curvature at deflections is one of the most important safety features in the design of a road.

It has been said that the most dangerous part of the machinery of transportation is the "nut" that holds the steering wheel of the atuomobile, but even the most careful motorist finds difficulty in safely negotiating the sudden deflections which are still far too numerous on our highways. Our chief concern in the matter of alignment is not the justification of our present standards, but rather to determine if we have yet fully realized the importance of easy curvature.

The avoiding of grade railway crossings is another feature of road location which is now being given more careful attention than formerly. We are improving the sight-line and placing "Stop" signs at particularly dangerous crossings which cannot be avoided, but eventually grade separations will have to be provided, as all grade crossings are dangerous.

The road allowances in Western Canada are laid out on the rectangular system, and a very recent improvement in road location in this province is the substitution of a diagonal road in place of the sectional line road, in order to reduce the distance between important centers.

The securing of additional width of right-of-way is the latest development in location work. We have found that a 66-ft. right-of-way is not adequate for a road that is destined to become a heavy traffic route, and we are now securing a 100-ft. right-of-way on some of our most important roads.

The traffic on our roads today is by no means confined to those who know the road, and until the awful toll of life resulting from motor accidents is reduced to a minimum, those of us who are responsible for the location of our highways must give our earnest consideration to safety features.

Highway Design.—In preliminary survey work, we found that a center-line profile gave only a very rough estimate of quantities, and we are now taking accurate cross-sections of the entire right-of-way at each station and at intermediate points where required. The sections are plotted, a trial grade line is run on the profile, the quantities are balanced and a continuous haul diagram prepared.

In plotting the sections we, in common with the neighboring provinces of Alberta and Manitoba, have discarded the old 10x10 cross-section paper in favor of a special cross-section paper with scales of 3 ft. to the inch vertically and 9 ft. to the inch horizontally. The large vertical scale enables the draftsman to plot the elevations as accurately as the readings were taken in the field, and this is impossible when the section is plotted to the same scale for both vertical and horizontal distances. On this special cross-section paper the old tiresome method of determining yardage by averaging and areas, multiplying by the length of the section and dividing by 27 to reduce to cubic yards, is dispensed with, and the number of cubic yards per station for any particular cross-section can be read directly from the planimeter.

Highway Widths.—The type and volume of traffic on our roads today is demanding a wider road surface. A motor bus or a large truck travelling at a high rate of speed is a formidable object to meet on a narrow road. Our standard width of road in Saskatchewan is 20 ft., but on our more heavily travelled roads we are widening the road surface to 24 ft. The province of Manitoba has adopted 24 ft. as the standard width for trunk highways. We have often been told, and I have repeated the statement myself, that the width of a road should always be a multiple of the width required for one line of traffic, namely, a multiple of 10 ft.; we were told that a 24-ft. road, for example, had the same capacity as a 20-ft. road, because they were both two-

lane traffic routes, but a 24-ft. road has an additional factor of safety for present-day traffic, particularly on an earth road, which, unfortunately, is not of the "non-skid" type. When gravel surfacing is undertaken, a 24-ft. road surface permits the gravel to be windrowed on the shoulder without seriously affecting the serviceability of the road; a windrow of gravel on a 20-ft. road surface would be a menace to traffic.

One of the comparatively recent improvements in the earth roads being constructed in Western Canada is the elimination of the old "peaked-roof" type of road, and the substitution of a sane and adequate crown height of approximately 4 in. on a 20-ft. road surface. High crowns have practically disappeared from main highways in Western Canada, but they are still to be found on secondary roads; but in common with all other motorists, I appreciate the steady progress which our municipal authorities are making towards the complete elimination of this most objectionable and dangerous type of road.

Grade of Slopes.—Three years ago, we revised our Saskatchewan standard specifications, to provide for a 3-to-1 slope on all embankments not protected by guard rail. We have since constructed approximately 1,400 miles of road and we are convinced that the easy slope is a wonderful improvement over the old 1½-to-1 slope, i. e., the natural slope of earth. Easy slopes on embankments are a protection to traffic, they increase the effective width of the road, and they materially reduce the amount of guard rail required. The 3-to-1 slopes must be built in place, and they are consequently consolidated to a much greater degree than 1½ to 1, or natural, slopes, and this fact makes it very much easier to keep the width of road surface uniform, and in good alignment.

Ditches.—For several years we used a V-shaped side-ditch on prairie sections where drainage was easily obtained, but we have had to largely abandon this type of ditch in favor of a flat-bottom ditch having a 3-to-1 slope adjacent to the roadway and of a width sufficient to provide the material required for the fill. The material obtainable from a "V" ditch was found to be inadequate, and this type of ditch became easily blocked with sediment on account of its comparatively small cross-sectional area. We keep the bottom of the ditch at least 3 ft. below the surface of the road.

Culverts.—Our experience in maintenance work has shown that small culverts readily become blocked with snow, weeds or sediment, consequently we are discontinuing the use of 12-in. and 15-in. diameter pipe culverts in the roadbed. We are now draining the small depressions into the large runways and are installing fewer but larger culverts. We have had a great deal of difficulty in keeping a sufficiently deep covering of earth on culverts installed in small fills, but by eliminating these culverts by ditching, and by placing culverts of adequate capacity in depressions where the height of embankment provides ample protection to the culvert, we can not only reduce our culvert losses, but we can reduce the number of washouts caused by blocked culverts.

We have found that an earth road, to be maintainable, must have its surface well above ground level on prairie sections, and should be not less than 3 ft. above highwater level in sloughs; consequently we have made a very material improvement in the type of road we are constructing by increasing the average yardage per mile. Many of our roads have 12,000 to 15,000 cu. yd. per mile, but the average volume of excavation per mile has been increased from 6,000 cu. yd. to 8,000 cu. yd. during the past two years. The wastage of material on an earth road is very considerable and early reconstruction work is avoided by building a substantial embankment in the first instance.

Winter Maintenance.—The demand for winter maintenance is a comparatively recent one in this province. It is very logical development following the advent of closed cars, coupled with an ever-increasing mileage of improved highways. The automobile has established a habit of rapid locomotion which is by no means seasonal, and we now hear ramblings of discontent when the sedan has to be replaced by the sleigh.

The problem of winter maintenance does not rest primarily upon snow removal, but rather on the prevention of drifts, consequently the prevention of drifts is a new feature affecting both the location and the design of our roads. By avoiding, widening or "daylighting" cuts, by carefully considering the direction of the prevailing winds when surface well above ground elevation, by the erection of snow fences and by the removal of weeds and brush from the right-of-way, we are endeavoring to meet the demand for all season roads.

It is interesting to note that deep cuts, on account of their larger storage capacity, do not become blocked with snow as readily as shallow cuts.

Methods of Construction.—Regarding improvements in the actual operation of building earth roads, we find that the slush scraper and the wheeler have practically been discarded by grading contractors. The fresno is used for short hauls and the dump wagon or motor truck for long hauls. During the past season the tractor has come into general use as the motive power for elevating graders. The tractor is much more manageable than 24 head of horses; it can turn, start and stop more quickly and can work 24 hours per day.

Formerly we were very much opposed to having material placed on the roadway by "side-casting" with an elevating grader, but if the material is fairly dry and is well broken down by the action of the tractor and by disc harrows, we find that a well-consolidated road can be obtained at a minimum cost. This summer we built a road by "side-casting" which carried a fleet of 3½-yd. trucks for a period of two weeks without developing the slightest trace of a rut even though the road was completed less than one month before being subjected to this severe test.

Safety Devices.—In the matter of safety and service, we have made further advances by the adoption of cable guard-railing instead of the dangerous and ineffective wooden guard-rail, which was designed for horse-drawn traffic. In the province of Saskatchewan we are using one ¾-in. steel cable supported on 6-in.-diameter cedar posts, at an elevation of 2 ft. above the level of the roadway.

Maintenance.—The features that make an earth road maintainable must be built into the road during its construction, and consequently I have considered it advisable to refer frequently to road maintenance while discussing recent improvements in design and construction. Efficient maintenance can be accomplished only by preventing damage instead of repairing damage. It consists, for example, in keeping the ditches and culverts clear, so that washouts will not occur, rather than repairing the washouts after they have occurred.

In regard to the maintenance of the road surface, a recent improvement is the substitution of heavier equipment in place of the old road drag. Motor traffic demands an even surface, and this can best be secured by means of a power patrol or a maintenance grader.

Maintenance work in general is not so much a matter of knowing what to do, and how to do it, but rather to continually keep on doing what we know should be done. A successful maintenance operator must have a keen interest in his task, and it is very difficult to get a part-time man to give even part of his interest to this work. Adequate and systematic maintenance is required to protect our huge investment in highways, and full-time maintenance patrolmen are replacing part-time men.

Conclusion.—There is no more difficult problem confronting highway engineers than that of properly constructing and maintaining an earth road. The work may be less spectacular than the construction and maintenance of hard-surfaced roads, but there is greater latitude in location, methods of construction and choice of materials, consequently there is more scope for the exercise of sound judgment on the part of the engineer.

Acknowledgment.—The above paper was presented Sept. 26 at the 16th annual meeting of the Canadian Good Roads Association.

Methods of Controlling Highway Landslides

A Report of Observations in West Virginia, Ohio and Southwestern Pennsylvania

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NEAR Barnabas, Logan County, W. Va., a slide moved down onto a road at intervals for four years. There was an exceptionally thick accumulation of detritus in a ravine formed by an old slide. Such an accumulation can very easily occur in the sandy, rocky materials of the local detritals. A large water supply reaches the area of the slide because of topographic conditions and the volume retained is great as a result of unusual thickness of detritus and its porous nature. This slide necessitated removal of 32,000 cu. yd. of material with steam shovels.

Following the last clean-up, cribbing was installed to check the slide. White-oak logs 12 to 14 in. in diameter at the butt and 12 ft. long were placed. The tie logs extending back into the slide were at intervals of 4 to 5 ft. Slope adjustment of the detritus, which began shortly after the setting of the cribbing, buried everything but the face of the cribbing, but the movement was finally halted. Previous expenditures at this point by the county have amounted to $17,300. The cribbing described above cost $2,200 for logs and $2,500 for labor. The slide is now apparently controlled; but the control is only temporary, as the cribbing timbers will rot and it is probable that the detrital mass will again move upon the highway.

Retaining Wall Holds Sidehill Fill.—In Green County, Pa., between Washington and Waynesburg, the highway traverses a hillside for a considerable distance. The surface material is decomposed shale, which freely absorbs water, as evidenced by crawfish holes in fields on both sides of the road. In many places side fills built of this unstable material go out and undermine the pavement. At one or two points drainage methods, which will be described later, have been employed for control of such subsidences, but in most instances where trouble has been encountered reinforced concrete retaining walls have been built on the lower side of the road. These walls have held the road in place. One typical wall is 150 ft. in length, 13 ft. high, and rests upon a 9-ft. footing which is set from 3 to 5 ft. in solid shale. Such a wall costs about $8,500, or about $57 per running foot.

Retaining Wall Placed Where Cheaper Design Would Have Been Adequate.—Federal-aid project No. 143-A, West Virginia, winds among high hills between West Union and Parkersburg. During grading operations 2 miles west of West Union it was found that the fill shoulder would not stand. The fill descends to a meadow, which is badly drained and very wet. The slide was not attributed to capillary water from the meadow, as it was thought that both the fill and the meadow were supplied with seepage from a somewhat previous shale or from a coal seam within it. A standard type concrete retaining wall was built 4 ft. from the edge of the pavement.

The illustration below shows the conditions at this location. More or less solid shale extends in places nearly to the level of the road, but it is not as compact as most shales in this district. It is quick to disintegrate under weathering influences, as shown by the retreat of its face beneath the ledge of sandstone above the road. The retaining wall has no surcharge, and considering the amount of material to be held by it the cost seems unduly high. Well casing could have been deeply set in the shale extending beyond the foundation for the retaining wall (see illustration) and filled with reinforced concrete. If spaced closely, they would form a thin and light type of wall, which would have cost much less than a retaining wall. Such a wall could have been back-filled with sandstone taken from the ledge above the road, and, with proper weep holes, having no serious pressure to withstand, could easily have held the road shoulder. The writer was among those responsible for the construction of a retaining wall and shares fully in the responsibility for it, but wider observations of similar cases are convincing that there is a cheaper and quicker way.

Saturated Fill Overturns Retaining Wall.—On West Virginia Federal-aid project No. 19, at a point known as White Rock on the West Fork River, a retaining wall was built on the river side to hold a side fill in place. The highway is located about 50 ft. above the river and the wall was founded on solid rock which outcropped along the river bank near the low-water mark. The gravity-type wall was keyed into the rock in the usual manner and was approximately 60 ft. in length, 15 ft. in height, and 6 ft. thick at the base. A fill consisting of some shale and rock, but mostly of weathered detritus, was placed back of the wall and extended from its top to the highway on a slope of 45°. Drainage channels were left in the wall.

After completion of this wall there was a period of high water in the river which lasted for several days, and the water rose to approximately the top of the wall. It then fell rapidly, and

Excavation for Retaining Wall to Hold Road Shoulder, Near West Union, W. Va.

within a few days was back to normal. Shortly afterwards the wall toppled over into the river. There was no breaking of the concrete. The wall remained intact, lying on its side in the water.

The explanation is simple. During the flood stage water flowed in through the weep holes and around the ends of the wall, thoroughly saturating the fill back of it. This caused no damage as long as the river was up, but when it fell to normal stage it removed the compensating pressure from the face of the wall; and the saturated material back of it, which exerted a more or less liquid pressure against the concrete, plus the effect of the surcharge of the fill above, caused the failure.

Slide in Putnam County, W. Va., Which Overturned a Retaining Wall

Another wall failure occurred in Putnam County, W. Va., where a cement-rubble retaining wall, 200 ft. long, set in shale about 75 ft. beyond, and well below the road shoulder, went out during a rainy spell. The cause in this case was apparently an excessive surcharge of the saturated fill above. A number of natural slides occurred at the same time in the vicinity, one of them about 100 ft. from the toe of the wall.

Controlling a Sliding Fill.—About 1912 Cabell County, W. Va., took over a section of abandoned railroad right-of-way from the Chesapeake & Ohio R. R. between Barboursville and the Putnam County line east of Huntington. On this grade the county built a 16-ft. grouted brick pavement on a concrete base. The state road commission of West Virginia took it over for maintenance on Jan. 1, 1922.

The road crosses a deep ravine on a fill about 450 ft. long at Lee's Creek, 2½ miles east of Milton. During the winter of 1924-25 a section of the fill near the west end started to move from under the pavement on the north side. In the spring the movement increased and it was necessary to support the pavement by tamping rock and other material under it. A section about 40 ft. long and half the width of the pavement finally failed.

In September, 1925, widening of the fill on that side was begun. In order to compact the new fill as much as possible, it was put in with wheel scrapers, starting at the toe of the old fill. The new fill was carried up about 10 ft. wide and was kept level, the teams traveling the whole length of the fill in going to and from the borrow pit.

This work was completed the latter part of September. During the winter of 1925-26 the new fill slid off at the same place where the old fill had settled, carrying still more of the old fill with it. About this time it was noticed that the ground at the toe of the fill was rising in front of the slide. This continued, as the movement of the fill progressed, until a section averaging 20 ft. wide and extending about 100 ft. along the toe of the fill had been lifted from 3 to 6 ft. above its original elevation.

In the spring of 1926 churn-drill soundings were made parallel with and at the toe of the fill. Rock was found at elevations varying from 4 to 12 ft. below the ground surface, the latter elevations being near the center of the fill.

It was decided to set well casing filled with concrete in this stratum. A well drill was used to sink 8-in. holes through the detritus and 8 ft. into the rock, which seemed to be a fairly hard sandstone. Well casings, 6⅝ in. inside diameter, were set in these holes and filled with concrete. Where the rock was more than 8 ft. below the surface, four ½-in. reinforcing rods were set in each casing. One hundred and twenty of such casings were set on 3-ft. centers. After these casings were completed, the slope of the fill was trimmed and ditched and no pockets were left to catch water.

During the winter of 1926-27 the fill continued to settle, although to a somewhat less degree than during the two preceding winters. Early in the spring of 1927, 12 of the casings where the rock was deepest showed signs of bending over. By the summer of 1927 they had failed completely. These were the casings which had been reinforced. The fill continued to sink from under the pavement in a section 40 ft. long. The break which had previously extended only to the center of the pavement now covered nearly the whole width. No sign of slipping appeared on the opposite side of the fill.

In April, 1927, a core drill was used to sink a line of holes parallel to the curb and about 2 ft. from it across the entire north side of the fill. Nothing but fill material and detritus was encountered to a depth of from 38 to 52 ft. below the pavement except a few scattered bowlders. The greatest depth to rock was in the bed of Lee's Creek, which crosses the fill about one-third of its length from the east end.

In August, 1927, 122 25-ft. oak piles were driven parallel to the pavement and about one-third of the distance up the slope from the casing. These were spaced 3 ft. apart. In October the fill was brought to the proper cross section by addition of new material. This material was distributed by hand so as

Fill Slide at Lee's Creek, W. Va.

to have the slope as uniform as possible.

At present the slide movement seems to have stopped. There is still a little settlement in the pavement, but this is to be expected as normal settling against the piling.

It is probable that this fill will continue to give trouble and that slumps and subsidences will recur, in spite of any physical-force methods of control, until the water problem is solved. A sluggish stream flows through a swampy tract near the foot of the fill. Old detritus and stream-deposited muck underlie one side, at least, of the fill. These are water-saturated in part from the stream, and in part from a water-bearing seam somewhat beneath the fill at its hillside contact and it is believed that a permanent remedy lies in drainage rather than attempts to hold back the fill.

Fill Slides of Various Types Described.—In southwestern Pennsylvania a concrete highway was constructed on a hillside. Part of this road crossed old slide material and at one point the grade line required a fill of 2 or 3 ft. on the uphill side and considerably more on the downhill side. The outer shoulder was built of shale and decomposed shale or siliceous clay. This fill extended down to a garden plot in front of a two-story frame residence erected on old slide material. A short distance beyond this residence the land drops sharply for a short distance to a small stream.

Not long after construction was completed a section of pavement dropped about 6 ft. vertically and the pavement was dislocated laterally for a distance of 200 ft. or more. A domelike bulge arose in the garden and the whole mass of the old slide moved sufficiently to break the foundation of the house, leaving the basement without walls on two sides, threatening the house and making it unsafe for occupancy. The construction of the highway added additional weight on the old slide but did not change conditions otherwise. The original mass must have been barely stable and a moderate load was sufficient to start it in motion.

The old slide was evidently fed by seepage through a non-compact shale near the road level. There are hundreds of cases similar to this in character. They are so frequent as to make imperative a study of local conditions before construction is begun. Such a study should include observations of wet spots following rainy spells, but after a general superficial drying of the surface. Where seepage is indicated, ample drainage must be established on the inside of the road.

In southwestern Pennsylvania a fill was constructed which contained 9,000 cu. yd. It was 60 ft. deep at the lower toe and 25 ft. at the upper toe. The material was decomposed disintegrated clay taken from an adjacent 18-ft. cut through laminated clay. The lower layer of the cut was quite plastic. Grading was begun in the winter of 1925 and was completed about the first of the following May.

Ten days after completion of the work the whole lower side of the fill went out, carrying about half of the roadway, which settled about 20 ft. It was evident that the fill material would flow readily when wet, but there was no evidence of seepage or sufficient rainfall to cause a slide.

A probable explanation of this failure is that the fill was built of clay, much of which was very plastic, in the winter time. The lower part of the fill was constructed with wet clay, much of which was frozen. A considerable load was placed on this material and when the winter and rains came the load was increased by moisture. The frozen wet clay thawed, the bottom flowed out, and the fill collapsed.

A retaining wall was built at the toe of the slide and the original 42-in. culvert pipe, 172 ft. long, was extended to a length of 200 ft. About 1,000 cu. yd. of rock placed on the side of the fill as it was built up, presumably with the idea of holding it in place, merely added to the weight on the underlying mucky ground and caused it to overflow the retaining wall and rise 4 ft. above its top.

A few miles west of Clarksburg, W.

Old Slide Started in Motion by Weight of New Highway Fill of Only Moderate Height

Va., a sidehill fill slid out from under a considerable portion of a concrete pavement. A row of concrete posts was installed to support the pavement, the backfilling was tamped in, and the road shoulder was refilled. The concrete posts were set in old detritus rather than in solid material; water continued to penetrate the fill; and it again went out, taking with it material from beneath the supporting concrete posts.

It is probable that deep but relatively inexpensive drainage installed inside of the road would have safeguarded the fill and pavement. The entire section of road was relocated, however, so as to place it on a solid shale.

Drainage Proves Effective in Stopping Slide.—One of the most interesting and instructive cases of slide and fill subsidence occurred on a highway on Bell Hill about 1 mile east of Morgantown, W. Va. An old county road descended the hill to a small valley where a bridge crossed a stream. The old road had required a small cut in shale and some underlying detritus on the hillside and the material had been thrown over the side and constituted a moderate fill. A number of years passed without record of noteworthy trouble.

Side Fill Slides and Resulting Damage to Highways

When the road was improved by the state as a Federal-aid project it was thought best to locate it further into the hillside on more solid material. The new road was placed 10 ft. back in the hillside, the bridge approach was raised 6 ft., and a new bridge was constructed. The hillside cut furnished material for the wedge-shaped fill downhill to the bridge, and a large surplus which was dumped on the hillside fill, making a very wide shoulder. The load on this fill was increased by building a high bank on the outer shoulder to serve as a guard for traffic. All of this was dumped on old slide material, wihch, however, was berm, and did not involve the area to be paved.

The road was graded in the summer of 1925, and in the fall or winter of 1925-26, a period of wet weather set in which was followed by a break extending diagonally across the road at a point about halfway down the hill. The location of this break is indicated in the sketch by the letter A. The road settled almost vertically, below the break. The bottom land below the slide showed unmistakable signs of many old slides, indicated by rolls or slight hillocks. After the road settled it was observed that the land near the bottom began to upheave and there were indications of considerable pressure apparently transmitted from the weight of the fill to the plastic subsoil below.

A slip also occurred in the sidehill fill at the point marked B. After the slip occurred a stream of water could be seen emerging from the solid material approximately 8 ft. below the surface of the road. This water had entered the loose fill on the hillside and so saturated the earth that it became semi-liquid, and settled down into the bottom of an angle of repose not exceeding 20°. At the top of this slip the ground rose almost vertically to the surface of the road, 8 ft. above the point where the water emerged.

Discovery of this stream of water led, quite naturally, to control by drainage. A ditch was dug along the upper side of the road which extended from the top of the grade two-thirds of the distance toward the small stream. Flowing water was encountered at a depth of approximately 8 ft. The ditch was carried approximately 10 ft. deep and into solid rock, and an 8-in. tile

Views of Slide on Bell Hill Near Morgantown, W. Va.

drain with open joints was laid on a gradient of approximately 3 per cent. The ditch around the tile was filled with broken stone and over this several feet of cinders were placed. The remainder of the ditch was filled in with earth. This drain intercepted the water as it flowed from the rock and discharged it into the open ditch near the small stream. The drain effectually stopped the flow of water into the slip below the road. Even in dry periods the discharge of water from the drain was sufficient to fill a 3-in. pipe. The fill along the lower side of the road (at point B) was then replaced to form a shoulder, and this fill has shown no signs of settlement since that time.

The slip, marked A, was filled in with cinders and appeared to be stable. In the late fall of 1926, however, a large water main supplying the city of Morgantown, which was located on the upper side of the road, broke as a result of a slide above the road and for a number of hours discharged a large volume of water into the slip and over the road at A. This water thoroughly saturated this slip and much settlement took place in the week following the break. As the road settled it was brought back to grade with cinders, and it was used as a cinder road during the winter of 1926-27. In the spring of 1927 it was observed that very little settlement or slipping had taken place during the winter months. Careful observations were taken over a period of four months in the spring and practically no settlement was observed. A concrete surface was then laid. Shortly afterward a settlement of about 2 in. took place along the lower side of the road, but no further settlement has occurred up to the present time.

It is believed that the breaking of the water main thoroughly saturated the slip and caused the maximum settlement for such material. There has been subsequent drying out and no further settlement has taken place excepting some slight readjustments.

Fall of Debris a Serious Problem.—Slide material precipitated in ditches and on roads is generally removed by steam shovels and trucks, but sometimes hand shoveling and trucks are used. Dribble constitutes the greater part of such material and its occurrence is very widespread. Eight steam shovels have recently been purchased for work of this character in eastern Ohio.

Often the cuts made in massive shale leave a vertical face rising to a considerable height above the road. If the shale is jointed, it is inevitable that frost action in time will precipitate large masses on the road below. Sometimes a broken condition results from heavy blasting during excavation. Similar dangerous conditions are also found in sandstone.

Vertical cuts may be left in shale if it is compact, without joints, and has not been deeply shattered by blasting. Otherwise, where possible, a suitable slope should be provided during construction. It is cheaper and safer to remove the surplus material then than to have to remove it from the pavement, and run the risk of physical damage, interference with traffic, and possible loss of life, at a later time.

The fall of much of this small material is not economically preventable, but attention should be given to bowlders and outcrops which endanger highway traffic. Projecting and unsupported sandstone and detached bowlders resting in an unstable position should either be pried loose or blasted and deposited below the highway.

Cuts should not be made in strata dipping steeply toward the road unless absolutely necessary. This is especially true if the rock has seams of clay or shale, even though only an inch or so in thickness. Where such a cut is made, rock beds above should be anchored in place in advance of blasting by a system of reinforced concrete piles set in drill holes.

Use of Wood Piles.—The use of wood piling is very extensive. It may be found in use in attempts—temporarily

Corrective Measures on Slide on Bell Hill Near Morgantown, W. Va.

Corrective Measures on Slide on Bell Hill Near Morgantown, W. Va.

more or less successful—to hold fills in place and to hold masses that have moved or threatened to move on a road. There are cases where a pavement rests in part upon old slide material and in part upon fill. Often the pavement is threatened with undermining and dislocation, and with being covered by material from above. In such cases piling has been placed at the foot of the fill and at the upper side of the road. As many as five rows may be seen at some points. Occasionally, for a single purpose, as many as three rows are placed. In some cases they are staggered, on 3 to 5-ft. centers, with rows 4 ft. apart. Frequently the piling is driven as close together as possible. In the illustration above, a row of piling may be seen so massed as to constitute a retaining wall. Oak piling used for this purpose varies from 20 to 30 ft. in length. A good and general practice is to drive it to refusal into an underlying bed of solid shale. Occasionally piles are used wholly in fill material to stiffen the mass, but this practice has not been very successful.

H. J. Spelman, division engineer of the West Virginia State Road Commission, has stated that the cost of such piling in his division when done by contract varied from $0.75 to $1 per lineal foot of timber. Many jobs have been reported as having cost approximately $0.90 per lineal foot of timber.

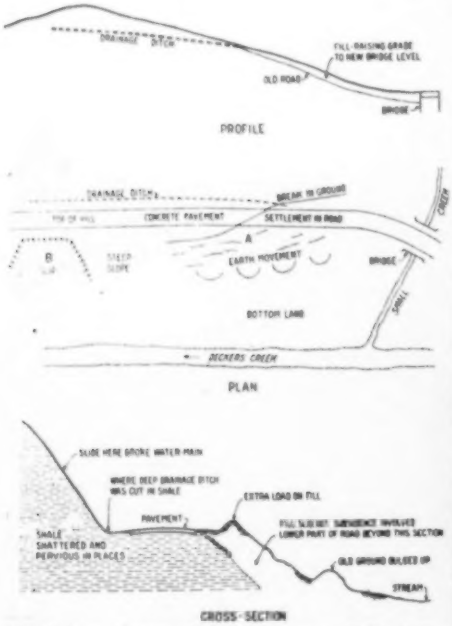
The use of wood piling is believed to have several disadvantages. It is never known in advance whether a single row will prevent the movement of a sliding mass. The sight of old piles either completely overthrown or pointing out from hillsides like cannon is not uncommon. After one row has been put in, if there is evidence of further movement, another row may be added and so on up to a maximum of five. Five rows may cost from $28 to $33 per lineal foot of road. The life of untreated wood piling, and this is almost universally used, is relatively brief. The United States Forest Service estimates it at approximately eight years.

Casings Filled with Concrete Often Used.—The use of piling formed by filling well casings with concrete has increased in popularity and is becoming extensive. The cost in this district is somewhat less than it would be elsewhere, as second-hand oil and gasoline casings can usually be purchased. The concrete filling is sometimes put in without reinforcing. Steel rods are the common reinforcement, but in a few cases steel rails have been used. Mr. Spelman gives the cost of such casing with reinforcing, at $1.11 per lineal foot of casing; but on many jobs it has cost $1.20 or more per lineal foot. No overhead is included in these figures.

This type of piling is often set from 5 to 8 ft. deep in so-called solid material, which is usually shale or sandstone. Both this type of piling and hardwood piling are often backed with planking, especially near the top.

The use of casing filled with concrete to hold any considerable mass of sliding material is always experimental. The piles may hold, and they may not. Sometimes rows of piling have gone out, probably because they were placed too near the edge of buried shale or rock which split under pressure.

In West Virginia, at a point known as the Godbey slide, the paved road which was buried is slightly above a



Conditions Surrounding Slides on Bell Hill Near Morgantown, W. Va.

Concrete Road Supported on Posts After Sidehill Slide

small river. A clean-up was made, and to avoid future trouble detritus was removed for a considerable distance beyond the inside shoulder of the road. This cut exposed a vertical face of solid shale 12 or 15 ft. in height, evidently made by the river earlier in its history. This condition shows remarkably well how casing might be set near the edge of such a face and result in failure. It is important that the outline of solid material be ascertained before such control methods are undertaken.

There are numerous failures where the cause is unknown. Casings may have been set in shale which softened, allowing them to tip over. They may have been bent or broken. It would be worth while to pull a few such piles to get more definite information.

Sheet Piling and Steel Rails Used.—Only one case of the use of sheet piling has been observed. On this job the sheet piling appeared to have stabilized the mass above it which was already nearly stable, but it has not prevented high water in the stream below from penetrating the fill, which was the intent of the experimental undertaking. The cost per lineal foot of such piling is intermediate between that of oak and reinforced concrete.

Rows of steel rails have occasionally been used by railroads for the control of slides, and in one or two instances by highway engineers, but not very satisfactorily.

Retaining Walls Extensively Used.—Retaining walls, although relatively expensive are extensively used, mostly on the lower side of the pavement, but not infrequently above the road and sometimes to protect residential property and cemeteries.

Many cases have been observed where the cost ranged from $35 to $60 per lineal foot and where less expensive protection such as casing filled with concrete would serve as well. Usually proper drainage on the inside of the road and beneath it will be cheaper and more satisfactory in results than a retaining wall.

A strong objection to the relatively expensive retaining wall lies in the uncertainty as to the magnitude of the forces that will act on the wall.

Roads Often Relocated to Avoid Slides.—As new highway projects develop, engineers in this district are concerning themselves more and more with the problem of relocation at obvious points of danger. The question presented is that of balancing the present cost of more or less extensive grading against the probability of sooner or later losing part of a paved road. Occasionally extensive changes in plans seem imperative.

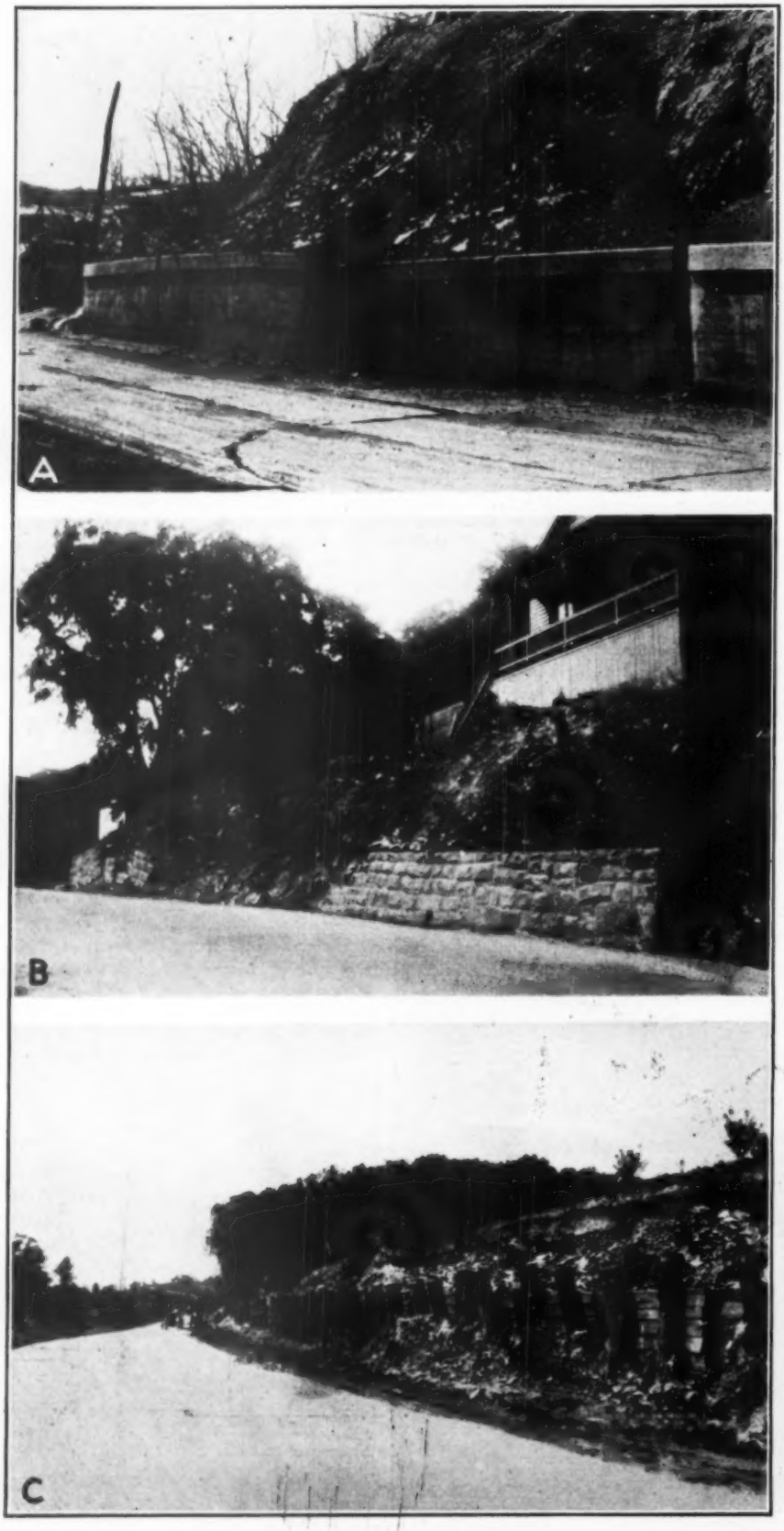
Cribbing Successfully Used.—The use of cribbing at the foot of a slide mass after a steam shovel clean-up is increasing. Cribbing has usually been built of untreated rough oak logs. Lately squared creosoted logs have come into use, and, very recently in Ohio, concrete units have been tried. The initial cost of the two latter types of cribbing is high, but the results obtained are likely to be permanent.

Casing Filled with Reinforced Concrete Used to Retain a Fill. Oak Piling Nearer the River Has Failed and the Concrete Piling Is Beginning to Fail. Drainage of Swampy Area on the Other Side of the Road Appears to Be the Remedy

Steel Piling Used to Hold a Fill

Closely Spaced Piling to Hold Road in Place

The illustration of cribbing on this page shows a case where the timber has become so rotten as no longer to prevent detrital movement. The old cribbing is being removed and reinforced concrete piling placed in its stead. It is not safe to depend on cribbing to retain an unstable mass which extends beneath the road. In such a case if a brute force method seems necessary, cribbing must be supplemented by piling. In typical cases observed, oak cribbing cost $10 and concrete cribbing $38 per lineal foot of road.



Types of Retaining Wall Used to Protect Road

Blasting.—Drilling through slide masses and near the toe of fills which are moving, or in which incipient movement has started, and dynamiting the underlying material is a time honored method of attempted control. It is often recommended by engineers, and in the area under discussion has been resorted to by some highway engineers. It has been used more extensively by railroad engineers in connection with side-fill slides. Some of them have adopted the practice of drilling holes 35 to 55 ft. in depth, extending 18 to 25 ft. into so-called solid material along the toes of fills. Holes are spaced 20 ft. apart, and after springing sometimes twice with 30 to 60 sticks of 40 per cent dynamite loads varying from 300 to 500 lb. of 40 per cent dynamite are shot in them.

There does not appear to be any evidence to justify the use of this method except in special cases. When used it is stated that it is experimental or that it opens up underground drainage and allows water to escape. Again, it is claimed that it roughens the ground beneath the fill and prevents sliding. This theory assumes that a fill slides as a unit on an underlying surface, whereas, in nearly every case, there is movement throughout the mass, or at least, the lower part of it. The movement is a slump rather than a slide.

If drainage channels are opened by blasting, relief is likely to be only temporary, for they will quickly be choked with fill material. In one case investigated holes were drilled to a depth of 17 to 20 ft. below the level of an immediately adjacent river and shot. It was stated that the advantage to be obtained was under-surface drainage.

Steel Rails Used to Hold a Slide

In several instances shale base lying below water level has been heavily blasted. In such cases it is not possible to avoid the belief that the blasted material will rapidly disintegrate into muck. Such practices can only result in very temporary control and must ultimately lead to the destruction of the only basis for rational control methods.

Under special conditions, however, there may be some advantage in blasting underlying solid sandstone or limestone.

Rock Loads of Little Value in Preventing Slides.—Several cases have been observed where large bowlders were placed at random on the outside of side fills. Usually the bowlders so placed gradually work to the toe of the fill. In a number of cases masses of bowlders have been assembled originally at the toe of a fill. The accompanying illustrations show two cases where a rock load is used to supplement piling.

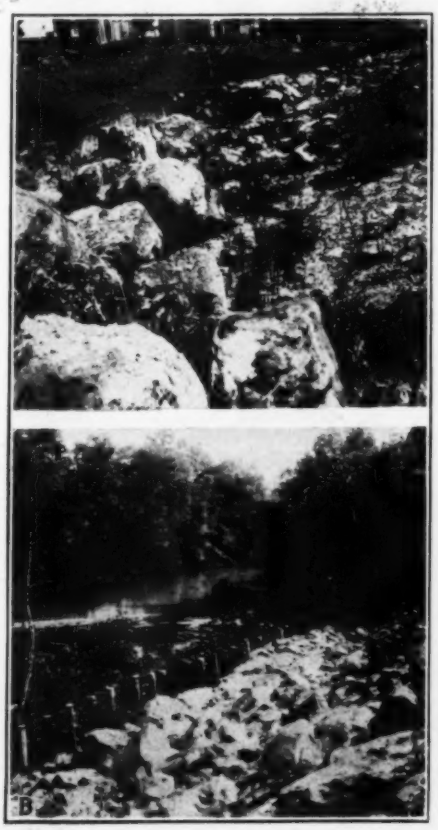
Bowlders distributed over a fill, apparently with the idea of holding the fill down by load, add nothing to the cohesive strength of the mass; they simply add further to the load, which is already too great. Bowlders massed along the toe of a fill probably do exert some retaining effect, but on the whole their use is of little value.

Drainage Believed to Be Solution of Problem.—The most important conclusion resulting from the study of slides in this district is that, generally speaking, preventive measures should be substituted for retaining structures. Usually a certain load is unavoidable. The nature of the detrital material is such that it is unstable when wet, the tendency toward instability depending on the fineness of the material and the clay content. The normal load and nature of the material can not generally be changed, but it is usually possible to eliminate the third factor causing slides, namely, water. It is not necessary to eliminate all moisture, but the content must be kept below the critical point at which it makes the mass unstable.

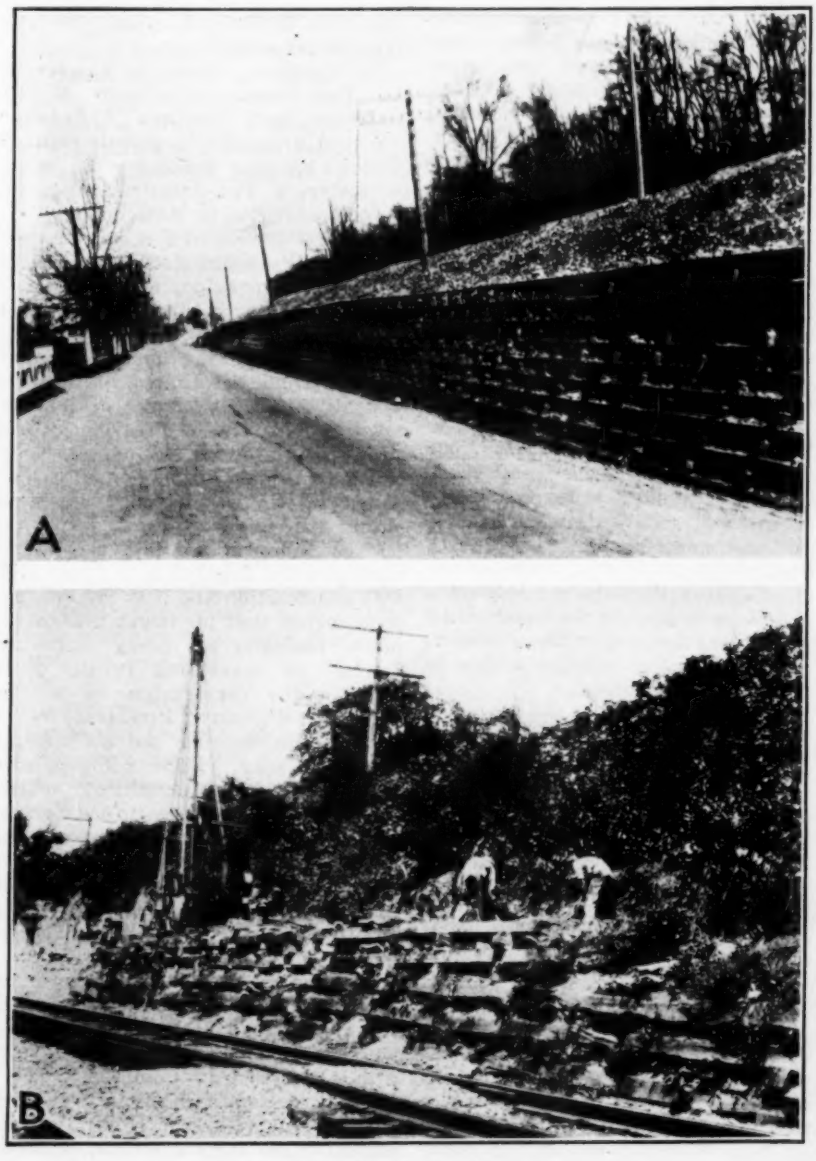
This may be done, according to the nature of the problem, by surface protection from penetration by rainfall, by surface drainage, or by underground drainage which reaches the source of seepage or flow. Side fills and through fills can be protected from penetration by rainfall where necessary. It is also possible to isolate them from underground water in most cases. Masses of overhanging detritus can generally be sufficiently drained to prevent movement.

Only sporadic attempts at drainage control have been made. A case at Morgantown, W. Va., has been described where drainage of underlying shale solved a serious problem. Small-size, open-joint tile has been occasionally used in soft spots in a road and French drains have been placed beneath inside ditches. Some surface drainage has been undertaken for the purpose of removing water from pockets of overhanging, old-slide detritus. Such work, however, has been neither systematic nor thorough. Lack of emphasis on prevention is common to most human experience and we spend money on landslides largely after they have occurred.

It is believed that this district needs more trenching machines, and fewer steam shovels and piles; that drainage will be found to be cheaper and more permanent than any control method



Masses of Rock Placed at Toe of Sliding Fill to Supplement Piling



Timber Cribbing for Slide Control

now employed; and that it must be undertaken with knowledge of local geological conditions. Detrital areas, which are traversed by roads, must be studied from a geological standpoint. Water seepage must be traced to its source, and water volume determined following rainfalls of varying intensity. Test holes or other means of interior exploration will answer this purpose.

If detrital material has been undisturbed for a considerable time, fine clay may have been washed downwards and accumulated below as in the formation of subsoils. Therefore, where slide material has been at rest for some time, the greater part of the underground water will be found comparatively near the surface, that is, within 3 to 5 ft. of it. In one case observed after a heavy rainfall, where a cut had been made in a thick mass of detritus, water was escaping in almost a solid sheet, along a plane about 5 ft. below the top of the cut.

Before fills are placed it is vitally important to observe whether the location is on ground which is wet not only during but for some time after rains. When wet spots are found, the source of the moisture must be located. Frequently it is in detritus on the hillside and after a fill is placed water enters from the side or end contact. The use of wet materials in building a fill, especially at or near its base, has been demonstrated to be a dangerous practice.

A number of illustrations of sidehill failures are presented because they constitute the most serious phase of the slide problems in this district. Most of them can be prevented by drainage on the inside of the road, or better, by drainage installed before the road is graded.

The annual damage resulting from the slides and subsidence is so enormous that systematic preventive experiments and study of relative costs and permanency of results is obviously justified.

It is believed that the solution of a very large proportion of the cases which arise, and this includes evidence of danger as well as slide movement, lies in the direction of drainage.

Annual Meeting of Highway Research Board

The Highway Research Board's 8th annual meeting will be held Dec. 13 and 14, 1928, at the National Academy of Sciences and National Research building, Washington, D. C.

Topics to be discussed will include: Practical methods based upon sound research for taking care of unusual drainage and other subgrade conditions, and for methods for design of pavements; new developments in finishing bituminous surfaces; factors to be considered in correlation of soil and pavement conditions; design of guard rail based upon extensive research in Pennsylvania; properties of bituminous materials for surface treated roads; safety on highways as affected by rural or urban conditions; degree of improvement of roadway, light or heavy traffic, increasing volume of traffic; effect of width of roadway and various physical conditions upon carrying capacity; the Maryland aerial traffic survey between Washington and Baltimore; methods used in promoting the financing of state highway systems; sound economic principles in financing road improvements; research work of the National Safety Council.

All persons interested in any phase of highway development are cordially invited to attend.

Sixty Thousand Attendance at Mexican Highway Congress

The Second National Mexican Highway Congress and Exposition held in Mexico City came to an official close on Oct. 6, having been attended by more than 60,000 visitors and delegates from twelve countries.

The Congress, under the auspices of the Pan-American Division of the American Road Builders' Association, was held primarily to give impetus to Mexico's highway building program and to foster a Pan-American Highway from Washington to Mexico City.

The first session of the Congress was opened by President-elect Emilio Portes Gil. The exposition was opened by President Plutarco Elias Calles and his cabinet. President Calles spent two hours inspecting the hundred exhibits brought from the United States demonstrating various phases of highway construction. Both President Calles and President-elect Gil expressed the belief that the construtcion of a Pan-American Highway would be completed within the next five years.

"The policy of the present administration in the Republic is to foster highway construction and it is my own personal belief that highways are an economic necessity for every nation and I shall do everything in my power towards the construction of a Pan-American Highway," President-elect Gil declared, in opening the deliberations on Wednesday. "The completion of such a highway, permitting tourists from the United States to comfortably visit our country and our own people to visit the United States, would be of inestimable value and do much towards cementing a stronger bond of friendship between the two nations," he told the American delegates.

Approximately 250 engineers and machinery exhibitors, members of the American Road Builders' Association, were in attendance from the United States. President Compton, head of the Association, declared in his address that a Pan-American Highway would attract more than a million American tourists annually.

E. L. Powers, Former Secretary A. R. B. A., Dies

E. L. Powers, president and treasurer of the Powers' Catalogue & Directory Co., Inc., died suddenly Oct. 22 of heart failure at his home 821 15th St., Wilmette, Ill.

Mr. Powers was a native of New York State. He was graduated from the Fredonia Normal School, Fredonia, N. Y., and from the University of Rochester. He was a member of the Delta Psi fraternity.

Mr. Powers was in the publishing business for over 30 years. He founded

E. L. Powers

Good Roads magazine. His publication, "Electrical Industries," was started in Chicago. His next publication was "The Automobile," later sold to H. M. Swetland, late president of the United Publishers' Association.

Mr. Powers came to Chicago in 1923 and published "Powers' Highway Catalogue," and in 1927 published "Powers' Construction Catalogue."

For about 15 years Mr. Powers was actively connected with the American Road Builders' Association as its secretary and business manager. It was largely through Mr. Powers' efforts that the first Good Roads Show was held in connection with the Good Roads Congress of the American Road Builders' Association.

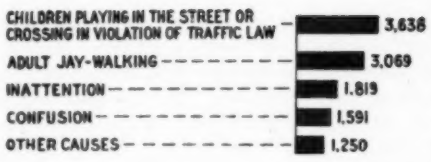
He is survived by his widow, Nan Sanders Powers and a 9 year old daughter, Margaret LaVerne Powers.

Sleeper Buses on English Roads.—The first sleeper bus service on English roads was inaugurated between London and Liverpool during the month of August. Additional routes are being planned.

An Analysis of Highway Accidents

Their Causes and Methods of Prevention

By CHARLES M. UPHAM
Secretary-Director American Road Builders' Association



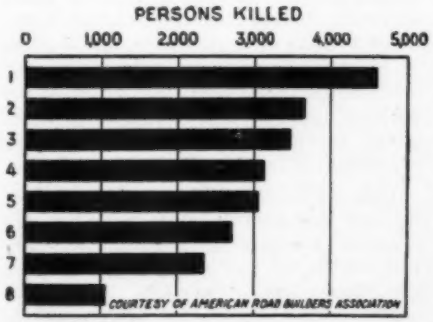
Fatalities Caused Principally by Pedestrians

THE daily cost of highway accidents in this country is 2,261 persons killed or injured, and an economic loss of nearly $2,000,000. During the year 1927, highway accidents exacted a total of 26,618 lives, 798,700 persons seriously injured, an economic loss of over $800,000,000, and property damage to some 8,000,000 automobiles.

Casualties Increased in 1927.—The 1927 casualties, according to figures of the American Road Builders' Association, showed an increase of 1,316 deaths over 1926. Minor accidents were estimated to involve 25,000 automobiles every day of the year.

What do these staggering figures indicate? Do they mean that the American people are becoming inherently reckless at the wheel of an automobile; that our systems of traffic control are antiquated; that the modern automobile is in itself a dangerous instrument; or that each one of these factors makes its contribution toward the general traffic hazards resulting in highway accidents?

Since the year 1922, the number of persons killed annually in highway accidents has been steadily increasing. In the former year, 19,203 persons were killed, as compared with 26,618 in 1927.

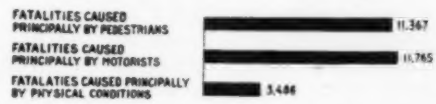


1-INATTENTION
2-CHILDREN PLAYING IN STREET OR CROSSING IN VIOLATION OF TRAFFIC LAW
3-PHYSICAL CONDITIONS
4-MISCELLANEOUS
5-ADULT JAY WALKING
6-SPEEDING
7-TRAFFIC VIOLATION
8-INTOXICATION

Causes of Fatalities

Fatalities increased 38 per cent during this period, while automotive registrations increased 90 per cent. This would seem to indicate that highway accident fatalities are decreasing in proportion to the number of vehicles in use. For practical purposes this is true. It is a fact, however, that the increase in highway accidents continues to climb steadily, while the annual increase in automobile registrations has failed to maintain its steady upward trend.

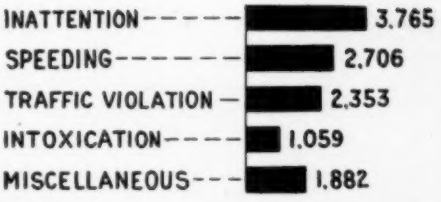
Cause of Increase.—This is caused by two things—the increase in population and the wider use of registered automobiles. The National Safety Council has made a careful study of the population factor in highway accidents. The Council believes population to be the most important factor in the annual increase of these accidents. The American Road Builders' Association points out that increased population



Summarization of Principal Causes of Fatalities in U. S. in 1927

not only causes more pedestrians to be upon the streets, but it increases the congestion of pedestrian traffic and the resultant confusion in a far greater proportion. This reasoning can only lead to the conclusion that the pedestrian problem in highway accidents is becoming of increasing importance each year. An examination of highway accident statistics will prove this conclusion to be true.

Accidents to Pedestrians.—Since 1922 the number of pedestrians involved in fatal highway accidents has been increased enormously. Today more than two-thirds of all fatalities are pedestrians. Last year pedestrians were the major factor in causing 11,367 out of 26,618 fatalities, as compared with 11,765 caused principally by motorists. In the first instance virtually all deaths were pedestrians, and in the second a large number were pedestrians. Massachusetts found that pedestrian fatalities were increasing in that state, while motorist fatalities were actually decreasing. The same is true in virtually all states of the Union, particularly in those having a large urban population.



Fatalities Caused Principally by Motorists

With these truths in mind, it must be concluded that even though the registration of automobiles should not increase at all, the number of highway accidents occurring each year would continue to climb at an alarming rate as a result of the constantly increasing population and wider use of motor vehicles. This gives rise to the immediate need for studies of methods of pedestrian education and pedestrian control in the United States. The National Safety Council has estimated that unless highway accidents are checked, 40,000 persons will have lost their lives as a result of them in 1935. This is no idle warning, as it is based upon concrete facts, with the present increase in population as one of the basic considerations.

Highway Fatalities Classified.—The individual causes of highway accidents are generally hypothetical. There may be many contributive causes to a single accident. Broadly speaking, these causes might be sifted to two characteristics of both pedestrians and motorists —carelessness and discourtesy. For analytical study, however, the American Road Builders' Association has prepared the following table of highway accident fatalities during 1927, showing

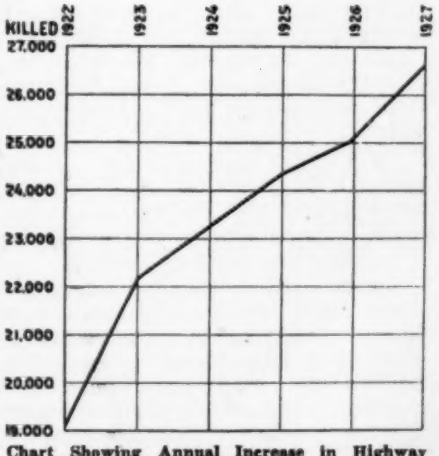


Chart Showing Annual Increase in Highway Accident Fatalities, 1922-27

the number of persons killed and the major contributive causes:

Fatalities Caused Principally by Pedestrians		
Children playing in the street or crossing in violation of traffic law	32%	3,638
Adult jay-walking	27%	3,069
Inattention	16%	1,819
Confusion	14%	1,591
Other causes	11%	1,250
Total fatalities caused by pedestrians		11,367

Fatalities Caused Principally by Motorists		
Inattention	32%	3,765
Speeding	23%	2,706
Traffic violation	20%	2,353
Intoxication	9%	1,059
Miscellaneous	16%	1,882
Total fatalities caused by motorists		11,765

Fatalities Caused Principally by Physical Conditions		
Fog, rain or snow	37%	1,290
Defect in vehicle	19%	662
Skidding	16%	558
Road defect	11%	383
Strong lights	7%	244
Poor street lighting	7%	244
Confusion in dimming	3%	105
Total fatalities caused by physical conditions		3,486

The Effect of Laws.—Enforceable laws will, in some measure, check those accidents resulting from speeding, intoxication, traffic violation and improper lighting. They will have some effect on adult jay-walking. In general, however, it may readily be seen that any attempt to pass additional laws will not strike directly at the root of highway accident causes, which fundamentally are the conduct of the individual. Last year the American Road Builders' Association estimated that 95 per cent of all highway accidents were caused by carelessness or discourtesy. The foregoing table bears out this statement. The three principal causes of fatalities—children playing in or crossing streets, inattention and adult jay-walking—took 12,291 lives or nearly 52 per cent of the 23,496 fatalities for which causes are listed. No amount of enforceable traffic law will reach those causes.

Conclusions From Studies.—The first six months of 1928 indicated another increase in the highway accident toll for the present year. When the final figures are made public at the Convention and Road Show of the American Road Builders' Association in Cleveland next January, it is believed that the death total will have reached nearly 28,000 for the year 1928. The conclusions drawn from studies of the accident causes will probably be the same as those for 1927, which are as follows:

First. That the human factor is responsible for 95 per cent of all highway accidents and that the mechanical and engineering factors are responsible for the remaining negligible portion.

Second. That the human factor which causes highway accidents is in a large degree caused by certain definable physical conditions such as conflicting traffic laws, traffic congestion, discourtesy, carelessness, physical incompetency and lack of confidence in the mechanical stability of a motor vehicle.

Third. That the pedestrian problem is increasing while the motoring hazards in themselves are only slightly decreasing.

Fourth. That the alarming number of children killed in highway accidents makes necessary some drastic action in their behalf.

Fifth. That no enforceable legislation will strike at the root of highway accidents.

Uniformity of Laws Necessary.—When faced with an emergency of the kind brought about by the present highway accident situation, the American people almost instinctively turn to law as the remedy. Rational action to reduce highway accidents, however, can not involve the adoption of additional laws, but rather necessitates simplifying and making uniform the existing laws. With confusion and traffic violation among the paramount contributive causes of highway accidents, the uniformity of existing laws looms as an outstanding panacea. With that in mind, the American Road Builders' Association heartily recommends the immediate adoption, so far as practicable, of uniform state and municipal vehicle laws prepared by the National Conference on Street and Highway Safety. The organization further believes that the examination and licensing of all drivers is essential for the progress toward highway safety.

Any additional move to reduce the highway accident toll must deal directly with the individual. Systems of pedestrian control have not as yet been developed to the point where they might be incorporated into a uniform national vehicle code, and until an adequate and successful system is developed, the various cities of the United States must continue to study their own particular pedestrian problems.

Educational Campaigns.—How can the individual be reached?

There are some 120,000,000 human beings included in the population of the United States. With this enormous group of people living among 23,000,000 automobiles there must always be highway accidents, both avoidable and unavoidable. It is not unreasonable to believe, however, that the present toll is much too high and that it may be reduced by an appeal to the individual. This necessitates constant education.

The immediate objective of an educational campaign for highway safety must be to instill in the mind of every individual a sense of personal responsibility, a desire to practice the principles of Courtesy and Caution. While it is realized that all persons may not be affected by a campaign of this kind, it is believed that those citizens who do realize the necessity for Courtesy and Caution and who practice it accordingly will eventually have an influence on the conduct of their fellow citizens. The ultimate result will be a national voluntary sense of caution which will find expression in wider and safer roads and streets, uniform signals and traffic laws and sensible personal conduct.

The safety education of pedestrians and motorists of the United States may be brought about only by the wholehearted cooperation of newspapers, periodicals, churches, schools, civic and social organizations, the radio and through every conceivable medium for transmitting a vital message. Only when the individual practices the principles of Courtesy and Caution as a part of his natural self, may the Nation hope for a reduction in the human toll it pays for highway transportation.

High-Type Highways Increasing Rapidly

With the cooperation of state highway departments, 8,184 miles of Federal-aid highways were improved in the fiscal year 1927-28, and 2,014 miles that had been previously improved by Federal aid were given surfaces of higher type, according to the Bureau of Public Roads, United States Departmen of Agriculture. This work was done at a total cost of $205,043,784, of which the Federal Government paid $88,056,984, or 43 per cent, and the states paid the balance.

Under supervision of the bureau, 281 miles of National Forest roads were improved, bringing the total improved mileage of these roads to 3,775 miles. The National Forest road system embraces, at present, a total of 13,911 miles.

In the Federal-aid system, there are 187,753 miles of interstate and intercounty highways, of which, on June 30, 71,074 miles had been improved with Federal assistance and 1,285 miles were undergoing state construction, that is, were being given a higher type of surface than when previously improved with Federal aid.

The 8,184 miles improved in 1928 include 2,182 miles of graded and drained earth roads; 844 miles of sand-clay; 1,836 miles of gravel; 92 miles of waterbound macadam; 464 miles of bituminous macadam; 136 miles of bituminous concrete; 2,533 miles of portland cement concrete, and 42 miles paved with vitrified brick. There were 54 miles of bridges and approaches.

Federal-aid highways are the most heavily traveled in the country. Increased demands of a growing traffic are shown by the greater increases in the types more suitable for heavy traffic. The mileage of high types of pavements built, such as bituminous macadam, bituminous concrete, portland cement concrete, and vitrified brick, increased 19 per cent in 1928, while the mileage of low types, such as waterbound macadam, gravel, sand-clay, and graded and drained increased about 9½ per cent.

Bituminous Treatments of Earth and Gravel Roads

Practice by State Highway Department of Minnesota

By H. G. NICHOLSON
Assistant Engineer, Minnesota Highway Department

IN the west and middle west during the last four or five years, a great deal of attention has been paid to the treatment of earth, gravel and gravel-clay roads with bituminous materials; that is, fuel oil, road oil, liquid asphalt and tars. From the activities of several of the highway departments, one might think that a new field in highway construction had been found. Perhaps this assertion is merited, but let us not deceive ourselves, for in the western part of the United States the application of crude asphaltic base oils and light residuums for the preservation of road surfaces was begun some 30 years ago, and in the eastern part of the United States tars have been used for the same purpose for at least as many years.

However, roads that were treated during the earier days have in a great many instances been supplanted by hard-surface roads, such as portland-cement concrete, asphaltic concrete, and heavy macadams, and for a few years the use of surface treatments waned, due to the intensive paving programs of various states and localities. In all fairness to the various highway departments for not developing what seems to be a much cheaper form of construction, it might be added that some of these roads were not successful, due to the increased traffic and lack of proper maintenance. Therefore let us not consider these bituminous-treated roads as a pavement, although in many cases they answer the purpose, both from an economical and psychological point of view.

The states most active in the present development of bituminous treatments are Oregon, California, Nevada, North and South Carolina, Wisconsin, Michigan, Illinois and Minnesota.

Conditions in Minnesota.—Since the material in the roadbed is the first problem to be considered in building up a road, Minnesota and other glaciated areas afford a much wider field for study and experimenting. In some parts of Minnesota the prevailing subsoil is a clay or gumbo, while in other districts the material is granular. Samples of the roadbeds have been taken and analyses have revealed materials ranging from 99 per cent clay and silt and 1 per cent sand to the other extreme of 99 per cent sand and 1 per cent clay and silt. Between these extremes, innumerable proportions of sand and clay and silt exist. To complicate conditions further, the sand may be a fine "blow" sand or a sand or gravel containing boulders, while the clay may be a light yellow residual (as in the southeastern part of the state) or a dense, sticky gumbo from glacial Lake Agassiz in the western and northwestern part of the state, and between these areas we find the third general classification of transported clays of glacial origin and silt.

From experiments carried on both in the laboratory and in the field, the class of bituminous materials most suitable for different types of soils is becoming fixed. Tars and road oils of a cut-back nature are being utilized on soils of a granular texture, while road oils of a low volatile characteristic are applied where the percentage of clay is in excess, and more especially on subgrade treatments. Experimental work is not dropped after the initial treatments, but is carried on further along lines of maintenance and construction.

As has been stated before in this article, tar and cut-back asphaltic oils or, more specifically, asphaltic oils of a high volatile content, have been pretty well established for gravel roads, and practice common to other states is used with a few variations. It must be remembered that conditions of roads in our state, as in other states where cheaper roads have been constructed, are far different from roads in states where heavier construction has been carried on over a long period of years. Gravel roads in our state consist of a thin crust of gravel compacted with clay as a binder, and not a consolidated or waterbound maccadam of 6-in. to 2-ft. thickness. Therefore, practice to us has to conform to existing conditions. In most construction a 30-ft. grade is carried, but only 24 treated. The traffic ranges from 600 to 6,000 vehicles per day on roads to be treated.

Method of Application.—As the method of application of tar and oil of a volatile nature is carried on in the same manner, we will discuss them under the head of tar application to avoid confusion in terms, but bearing in mind that either may be used.

The roadway is first bladed smooth and true to cross-section by means of a 10-ton tractor and a 12-ft. blade or a motor-driven patrol grader, care being taken to disturb the compacted crust as little as possible. The former is preferable, as a smoother surface is obtained. The loose gravel on the roadway is then bladed to the shoulder, on which the additional cover material has been previously placed. The cover material, with the gravel salvaged from the road surface, amounts to 325 to 375 cu. yd. per mile. The gravel is material which will pass a ¾-in. screen and does not contain an excess of fines.

When the roadway is in this condition and dry, the application of tar is in order. In some cases, sweeping the surface is reverted to, but only when the base is firmly compacted to a depth of 5 in. or more. This, you will note, is a deviation from the older practice.

Half the roadway is treated at a time, to afford room to carry the traffic at minimum inconvenience. Where the width of the roadway does not permit the windrowing of the gravel on the shoulder, the cover material is windrowed in the center of the road or just a little off the center, away from the side being treated. This often tends to keep the traffic off the side being treated, but additional care must be taken to avoid a weak strip in the center of the roadway, caused by too much loose gravel preventing the penetration of the tar into the roadbed.

An 8-ft. width of tar is applied immediately next to the windrow of gravel at the rate of 0.3 to 0.5 gal. per square yard. One to two miles is covered in this manner. A power patrol precedes the distributor to blade off as much of the loose material as possible. This application, or prime coat, is applied at a temperature of 135° F. to 150° F. A 4-ft. width is applied adjacent to this, and half of the roadway is allowed to "set," the tar penetrating into the roadbed. This usually takes from one to ten hours. The work can be laid out in such a manner that this setting action will take place overnight.

The second half of the roadway is then treated in a similar manner and traffic is carried on the side with the prime coat. The tar does not pick up but the weak spots are brought out and can be patched before the seal coat is applied. The only variance in treating the second side is that a 4-ft. strip is applied next to the side with the prime coat, making a lap of about 6 to 8 in. Then an 8-ft. spray is applied adjacent to the 4-ft. spray. This enables the distributor to travel on roadway free from tar.

When the second side has "set" sufficiently to handle traffic without "picking up," the applying of the second or seal coat is in order. Traffic is then diverted to the side not receiving the second coat. Again starting next to the windrow of gravel, an 8-ft. width is applied at the rate of 0.3 gal. per square yard. This is applied at a temperature of 125° F. A power patrol equipped with rubber tires immediately pulls the gravel over this application, spreading the material about 1 to 1½ in. deep. Care should be taken not to load the patrol with too much material, as a side thrust on the machine will be detrimental to the surface. There is plenty of time between loads to make several trips, carrying in small amounts at a time. The seal coat is applied over the entire surface and as soon as the gravel has been spread, the roadway is ready to carry traffic.

Blading or dragging of this surface mixes the gravel and tar, and with the aid of traffic a uniform surface is obtained. Dragging or mixing is carried on until the surface "sets up." This usually requires three or four days.

Any weak spots or breaks that develop after the blading is discontinued are immediaately patched with premixed material, using the same grade of tar and gravel as that used in the treatment. This maintenance must be done consistently and conscientiously or the quality of the surface will be greatly impaired. In fact, bituminous treatments should not be attempted unless an experienced, well-equipped maintenance organization is on hand to handle the work.

If waviness develops after the tar sets up, the corrugations can be removed by cutting or planing the ridges with a large blade, set at an angle of 45°. This operation is best performed on a hot day.

A road thus constructed costs about $1,500 to $1,800 per mile for a 24-ft. treated surface for the first year. This includes cost of gravel and application.

Second Year Treatment.—The second year treatment consists of a light application of tar of about 1/5 to ¼ gal. per square yard, and covered with 125 to 150 cu. yd. of gravel per mile. This treatment costs about $750 per mile. In a good many cases no treatment outside of patching is required during the third year, unless the traffic has been over 1,500 vehicles per day.

If the road does become unduly wavy or rough, it has been demonstrated that the surface can be scarified and reshaped at a small cost.

Specifications.—Below are the specifications of tar used for the above treatment, and also the specifications for the asphaltic road oil when that material is used:

Tar

The refined tar shall be homogeneous and meet the following requirements:
Water by weight, not more than 2%.
Specific viscosity, Engler, 50 cc. at 40° C. .....8 to 15
Total bitumen soluble in carbon disulphide, not less than 88%.
Distillation test on water-free material—
Total distillate by weight, not more than—
0 to 170° C. 7%
0 to 270° C. 32%
0 to 300° C. 42%
Softening point of residue, not more than..60° C.

Road Oil "B"

The road oil shall be homogeneous, free from water, shall not foam when heated to 120° C. (248° F.), and shall meet the following requirements:

Per Cent Residue, 100 Penetration	Specific Viscosity at 60° C.
40-50	3-12
50-60	10-20
60-75	10-25

Ductility of residue, not less than.....50 cm.
Specific gravity 25° C./25° C.....0.935-0.980
Total bitumen soluble in carbon disulphide, not less than.....99.5%
Total bitumen insoluble in 86° B. naphtha, not less than.....12%
Flash point .....45° C.-90° C.
Loss at 163° C., 50 gms., 5 hrs.....12%-27%

Treatment of Subgrade.—In 1925, due to the evidence of diminishing supply of gravel, and also the inherent characteristic of certain subsoils to "eat up" gravel, experiments on gumbo and clay were tried, hoping to waterproof the grade in order to hold the gravel up and the water out. It was hoped that gravel consumption could be reduced and the road made more serviceable during all seasons of the year. Especially on the gumbo, during the spring and fall, the consumption of gravel is extremely high, with no apparent increase in stability of surface. The rains and spring "break-ups" make these roads muddy, sticky and rutted, requiring an unlimited expenditure of funds to get traffic through.

The first attempt toward the solution of this problem was the use of a road oil applied in two applications of about 0.3 gal. each per square yard. This oil was not covered with gravel, and difficulties were encountered which discounted the method; but the mere fact that the oil did waterproof the road and did stiffen or toughen the crust, encouraged the department to go further.

The outstanding difficulty of the foregoing process was the inability of preventing the "picking up" of the oil and more especially by steel-tired vehicles. These roads are in rural communities and the latter class of vehicles are numerous. Then, too, when the road is oiled and not covered with gravel, it develops a slippery surface which introduces a hazard, especially in wet weather. It might be stated here that the gravel takes a great deal of the wear of traffic. The cost of patching and maintenance is higher on this type of surface, and scarifying has to be done more frequently, which again requires more oil.

At the same time that the above experiment was being carried on, several other experiments on clay and gumbo were tried, using varying amounts of oil and gravel for covering material. The results were encouraging, and the following year the oiling of subgrades on a large scale was started.

Method of Oiling Subgrades.—The roadway to be treated is first allowed to take traffic for some time, thereby bringing out the weak spots in the road. These defective areas, sags or pockets of non-uniform material are filled with the prevailing clay or gumbo, and the roadway is then subjected to intensive blading or planing to develop a very smooth surface. The ability of this class of soil to pack and harden, soon has the roadway in a uniform, smooth, fast surface. While this operation is in progress, gravel is windrowed along one shoulder of the road at a rate of 350 to 450 yd. to the mile, ready to be bladed over when the oil is applied.

When the road is shaped and dry (the latter cannot be emphasized too strongly), the application of oil is started.

Half of the roadway is treated first with a prime coat of as much oil as the material will absorb. This usually is between 0.35 and 0.55 gal. per square yard. It is applied with a power distributor at a temperature of 175° F. to 200° F. When this oil has driven in so that it will not pick up, traffic is allowed to use this side of the road and the prime coat applied on the other.

After the entire roadway has received the prime coat and is dry, a seal coat is applied, starting on the side of the road first primed, which is also the side on which the gravel is windrowed. The application of the seal coat can be at a lower temperature, about 160° F., and at the rate of 0.3 to 0.35 per square yard. As soon as the seal coat is applied, or within half an hour afterward, a power patrol equipped with rubber tires and a 12-ft. blade pulls the gravel over the oiled surface.

The entire surface is covered in this manner, and the roadway is then ready to carry traffic, which benefits the treatment without inconveniencing anyone. Some of the gravel is driven into the grade and also mixed with the oil, but a thin layer of gravel is kept floating over this treatment, and with the exception of a slight discoloration, exhibits all the characteristics of a good gravel road.

Maintenance on this type of road, consisting of blading and planing, is started at once and carried on systematically. However, the patrol sections are lengthened and one patrolman can successfully handle 20 miles instead of six to ten miles of the gravel road. In some cases power patrols are used, but in most cases spring blades mounted on trucks are found very satisfactory, with the occasional use of supplementary equipment.

Second Year Treatment.—During the second year the roadway is bladed free from loose material, and a light application of the same kind of oil used the first year is applied at the rate of 0.2 to 0.3 gal. per square yard. This is again covered with a thin coat of gravel. About 125 to 150 yd. to the mile of

additional gravel is needed as a cover coat.

In places where break-ups have occurred, or where extreme roughness is in evidence, a light scarifying will remedy the difficulty with little additional cost.

The cost of this treatment ranges between $1,200 and $1,800 per mile the first year, and half that amount the second year. In some cases the third year can go without any treatment, but it is usually advisable to repeat the second year treatment.

Road Oil "A" Specifications.—The road oil shall be homogeneous, free from water, shall not foam when heated to 120° C. (248° F.), and shall meet the following requirements:

Per Cent Residue, 100 Penetration	Specific Viscosity at 60° C.
40-50	2-10
50-60	7-20
60-70	10-25
70-80	15-40

Ductility of residue, not less than.....50 cm.
Specific gravity 25° C./25° C., not less than..0.975
Total bitumen, soluble in carbon disulphide, not less than.....99.5%
Total bitumen, insoluble in 86° B. naphtha, not less than.....9%
Flash point, not less than.....90° C.
Loss at 163° C., 50 gms., 5 hrs, not more than 6%

Conclusions and Observations.—For the class of road developed, it is cheaper and more expedient to treat clay and gumbo subgrade with oil before the application of gravel if the gravel has to be hauled any distance, or if the subgrade possesses the inherent characteristic of "eating up" the gravel without giving any stability to the surface.

The dust hazard is practically eliminated, making travelling more pleasant and safe for the riding public, to say nothing of the relief that property owners and people along the highways experience.

Maintenance costs are reduced by the saving of replacement gravel and also the lengthening of patrol sections. One patrolman and helper can easily take care of 20 to 25 miles of bituminous-treated road instead of the 6 to 8 miles of dirt or gravel road.

A more serviceable road for all seasons of the year is developed. Storm water does not soak into the road surface.

Bituminous-treated roads can carry economically a larger number of vehicles than an untreated surface. In Minnesota the average daily vehicle census on bituminous-treated roads was 1,275. The heaviest travelled road in the state was a bituminous-treated road carrying an average of over 6,000 vehicles daily. From statistics compiled in Minnesota for 1926, the economical maximum limit for gravel roads was 587 cars per day, and all of the bituminous roads are carrying well over this number without showing signs of distress.

In the use of bituminous materials you are putting something into the road that will not decrease in value as time goes on and subsequent treatments are made. This statement may seem axiomatic, but the oil or tar helps to build up a foundation suitable for heavier treatments, waterproofing and stabilizing the crust more with each successive treatment.

Acknowledgment.—The foregoing paper was presented Sept. 25 at the 15th annual meeting of the Canadian Good Roads Association.

Traffic Counts in Michigan

By FRANK F. ROGERS
State Highway Commissioner of Michigan

Late in 1926 it was decided by the State Highway Department that in view of the large amount of open road during the winter, from extension of our snow removal system, a change in the method of taking traffic counts would be necessary. Prior to this time, traffic during the year was spread over only that portion of the year during which the roads were open, and hence it was not a 365 day year so far as highway traffic is concerned. With the open road the year round, the situation became considerably different, and it was necessary in order to secure a fair average value for traffic to extend the counts throughout the winter season.

In order to secure an average value the year is divided into four traffic quarters in which the months are grouped, not according to their place in the calendar year, but according to the amount of traffic during these months. These quarters were decided upon, both from our experience in traffic counts and from the records of the amount of gasoline tax collected during the month. The first quarter is January, February and March; second quarter April, November and December; third quarter May, June and October and the fourth quarter July, August and September. Within the quarters it is attempted to take counts during the month which is nearest the average for the quarter. In the first quarter the heaviest traffic is in March, the lightest in February and the average in January. In each quarter counts are taken for 14 hours on both week days and Sundays, in order to get the average daily count for the 14 hours, and in half year there is one 24-hour count, so as to determine the percentage of traffic in the first 14 hours. This percentage is used in converting the other 14-hour counts to 24-hour counts. In addition to the regular counts just mentioned, there is, in the middle of August, a count taken in order to secure a figure for the maximum traffic.

Wherever possible, stations at which the counting is done are placed at road intersections, so that it is possible to determine the change of traffic due to its entering or leaving the trunk line road at this point. In this way also, it is possible to secure a large number of counts on county roads at no additional expense. This information is valuable in comparing the amount of traffic on the trunk line roads with that on the county roads.

Previous to 1928 it had been the policy to count the horse-drawn vehicles, but from the figures taken in the 1927 count, it became quite evident that the percentage was so small that it may this year be neglected. Vehicles then, are now classified as autos from other states, Michigan automobiles, busses, trucks 1½ ton and under, trucks over 1½ tons and truck trailers. These figures are all summarized on the basis of the 24-hour daily average and the total number of vehicles passing over the road at any given point in the year obtained by multiplying this daily average by 365. The figures obtained for the average daily traffic and maximum daily traffic have this year been platted on a traffic map, in order to see graphically the distribution of traffic over the highways of the state. Those counts taken on county roads are shown as short stubs off of the trunk line roads. The figures obtained from the total number of vehicles annually, are used in computing the vehicle mile cost of maintenance.

Acknowledgment.—The above is abstracted from a paper presented Oct. 23 at the annual meeting of the American Society for Municipal Improvements.

Foresters on Pennsylvania Highway Staff

James L. Stuart, Secretary of the Pennsylvania Department of Highways, commenting on the transfer of John W. Keller, former Nurseries Chief in the Department of Forests and Waters, to the Department of Highways as a special engineer in charge of highway forestry, declared that "The utilitarian features of intelligent planting along highways after careful study by an expert undoubtedly will be reflected by immediate returns in reduced maintenance costs on the highway system. Beautification of the highways which will be one of the results is not," the secretary said, "the department's primary aim."

One of the advantages of trees pointed out by Secretary Stuart is in the formation of wind-breaks with evergreen trees which will cut down snow drifting and in time take the place of many miles of snow fence. The benefits, the secretary declared, would be enormous with practically no replacement of the trees required, whereas snow fence is costly and comparatively short lived.

Preservation of the berm and embankments along the highways through trees and vines would save very appreciable sums spent each year in the repair of roadsides damaged by wind and flood.

Indirect benefits of the trees and shrubbery will be numerous, Mr. Stuart concluded.

Map of the United States, Showing Snowfall, Using Contour Lines to Express Depth in Inches; From U. S. Weather Bureau and U. S. Bureau of Public Roads Records

What the Various States Are Doing in the Way of Snow Removal

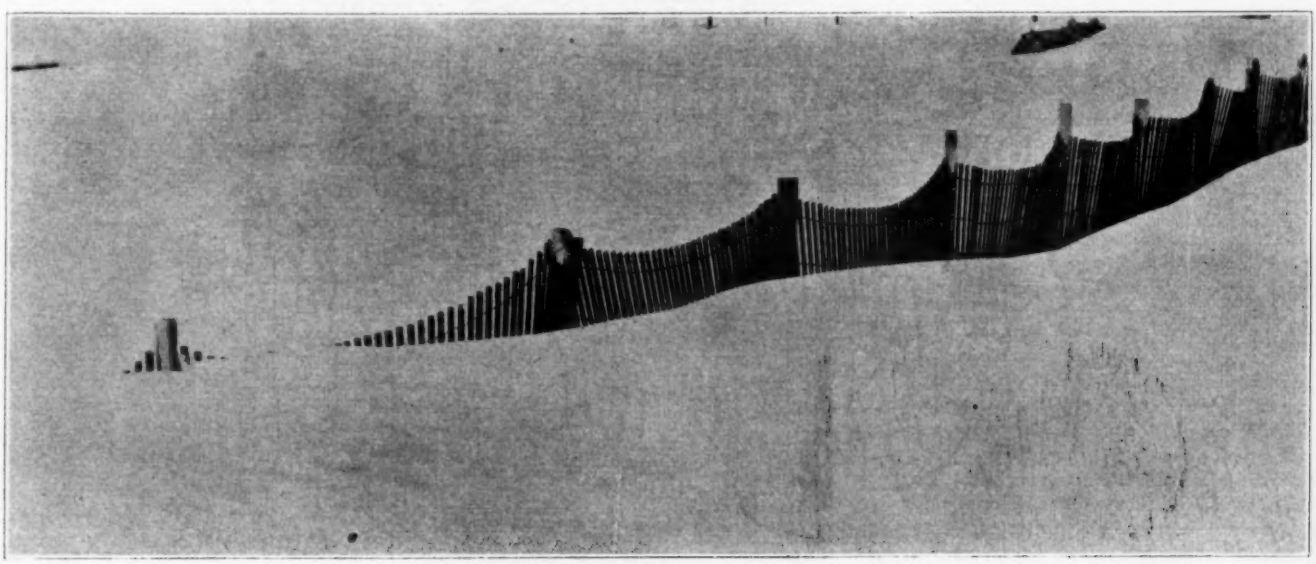
Notes on Cost, Equipment, and Policies as Recently Reported

At the beginning of another winter it is time to take stock again and see just how snow removal programs have been developed in order that our main highways may be kept open to traffic between now and next spring.

In order that some constructive and interesting data might be presented to the readers of this journal, letters have been sent out to a large list of city, county, and state officials, and data has been compiled as received from these sources, as well as from the Weather Bureau, the United States Bureau of Public Roads, and manufacturers of snow removal equipment. This article, based upon the information thus gathered, is now presented to our readers, with due credit and thanks to the above mentioned officials, bureaus, and manufacturers for the help that they have rendered. Detailed information regarding available equipment has been presented in a separate article.—The Editor.

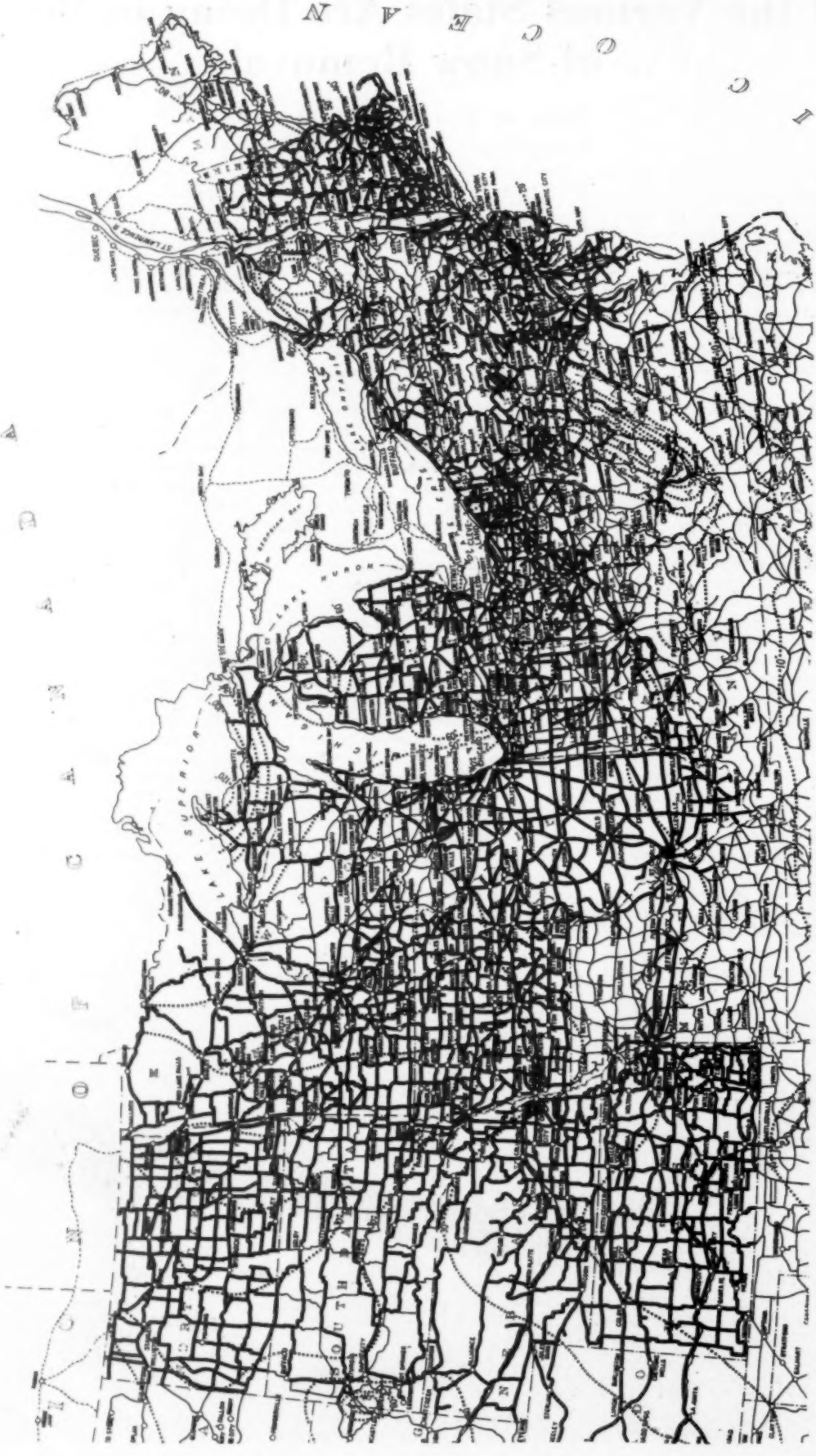
SNOW removal programs have apparently reached a point of stabilization among the states, and but little snow removal work of an extensive nature is done by counties, if we are to judge by data available at this time on the work of the past few years and the plans for the coming years as announced by those to whom inquiries on these matters have been sent. City snow removal work, not treated in this article, has shown about the same condition. For a few years snow removal activity has advanced by leaps and bounds in the 36 states where snow removal is at all a problem, but now the increased purchase of equipment that has been a feature of past years has slowed down, and purchases are more in line at this time with those necessitated by replacement with more efficient equipment on the basis of corrected ideas with regard to the most feasible methods, and in line with the requirements of increased traffic over the various highways. According to a report by H. G. McKelvey, of the division of construction of the U. S. Bureau of Public Roads, the various state highway departments in the 36 states with a snowfall of over 20 in. annually increased their snow removal programs by 50 per cent annually until the winter of 1926-27, when the increase dropped to 15 per cent. The mileage covered last winter he estimated at 117,109 miles, or an increase of about ten per cent over the mileage of the preceding winter. A further mileage increase of possibility ten per cent might be expected for the coming winter, on the basis of reports so far received by this journal. This increase will be partly taken care of through the more efficient action and greater speed made possible by the use of modern high speed truck patrol equipment, while some will necessitate the purchase of additional equipment. The same authority, citing Table 1, showing herewith, states that in the four-year period beginning with the winter of 1922-23, the state highway departments quadrupled the mileage of their snow removal operations, and the total expenditures increased sixfold. The average cost of snow removal per mile of road has increased over 55 per cent due to the demand for more complete clearing and unobstructed winter travel. A small increase in the average cost per mile that is shown in the tabulation, when comparing the last two winters shown, as well as the small increases for the past winter over the last one shown in the tabulation, probably indicate an early approach to a satisfactory standard of service.

That these conclusions drawn from Table 1 are correct may be confirmed by an inspection of Table 2. In the winter of 1922-23 there were only 184 truck plows and 221 tractor plows in operation in the entire 36 snow states. In the next three-year period the total truck and tractor plows increased eightfold; the increase during the next year then dropped to 16 per cent. This would indicate that equipment to take care of the large mileage of roads was purchased as rapidly as funds were available until such a time as the main traveled roads of the state systems were brought under effective control by the snow-removal forces. It is interesting to note here that while in 1922-23 the relation between truck and tractor plows was in the ratio of 5:6, that four years later in 1925-26 that ratio had been reversed to 5:2. This is in keeping with the general demand for fast-



Snow Fence of This Type is Widely Used to Reduce Plowing Costs

Map of the United States, Showing Snowfall, Using Contour Lines to Express Depth in Inches; From U. S. Weather Bureau and U. S. Bureau of Public Roads Records



This Map Indicates the Greater Part of the Main Highways Kept Free FromSnow by State and County Forces (Courtesy U. S. Bureau of Public Roads)

Table 1.—The Increase in the Snow-Removal Mileages and Expenditures in the 36 Heavy-Snowfall States Over a Four-Year Period Beginning with the Winter of 1922-23

Winter	Total Roads With Snow Removed Miles	Increase Over Preceding Year	Total Cost of Snow Removal	Increase Over Preceding Year	Average Cost Per Mile
1922-23	27,096	....	$ 762,159	....	$28.12
1923-24	41,302	52%	946,262	24%	22.91
1924-25	62,167	50%	1,826,813	93%	29.39
1925-26	93,006	50%	3,757,663	106%	40.38
1926-27	106,721	15%	4,641,037	24%	43.50
1927-28	117,109*	10%			

*Estimated.

Table 2.—The Increase in the Amount of Equipment Used in Snow-Removal Operations in the 36 Heavy-Snowfall States Over a Four-Year Period Beginning with the Winter of 1922-23

Winter	Truck Plows	Increase Over Preceding Year	Tractor Plows	Increase Over Preceding Year	Total Truck and Tractor Plows	Increase Over Preceding Year	Miscellaneous Trucks	Miscellaneous Tractors
1922-23	184	....	221	....	405	....	.....	.....
1923-24	1,227	567%	287	30%	1,514	274%	.....	.....
1924-25	1,456	19%	446	55%	1,902	26%	.....	.....
1925-26	2,546	75%	803	80%	3,349	76%	3,943	1,348
1926-27	2,827	11%	1,069	33%	3,896	16%	4,365	1,600

moving units, continuously operated during snowfalls, to keep the roads open to traffic at all times. The existing policy is a decided advance over the original procedure when it was considered necessary only to begin snow removal after the storm had passed, thereby causing a considerable loss to transportation agencies temporarily blockaded while the snow was falling.

The status of equipment on hand, mileage covered, total cost, etc., as of the winter of 1926-27, can be seen from Table 3. An idea of the situation facing the states this winter may be gained from various statements published later on in this article.

Types of Equipment and Use.—The snow removal equipment used on state highway work will depend upon the extent and depth of the snow to be removed. Light snows are removed by means of ordinary grader equipment or blade type plows mounted on motor trucks or tractors. Heavier snows are removed partly with the same equipment but more often with "V" type plows on motor trucks or tractors and by means of rotary plows mounted on trucks or tractors. The choice of truck or tractor equipment is one that requires study. Truck-mounted equipment has the advantage of speed and does not tear up macadam and other soft types of pavements. Tractor equipment, on the other hand, affords great power for bucking particularly heavy drifts. The modern conception of a snow removal policy is that of having at hand a plentiful supply of high speed equipment, and operators subject to sudden call, day or night, as in a fire department. At the onset of a storm, this equipment is all rushed out on the roads, each unit having its own predetermined route to clear, and the equipment is kept moving until the storm is over or the roads opened. Patrols, between storms, see that the route remains clear. Roads are kept open to full width, with low banks to provide means for storing the snow from following storms, and ditches are kept open when possible. A reserve of heavy equipment may be kept on hand to deal with particularly heavy drifts should such be encountered. This may be of the tractor type, delivered to the desired point on an equipment trailer towed by truck. There are many makes of equipment of these types on the market, each having its advantages and disadvantages, and the selection of any should be predicated upon careful analysis on the part of the purchaser, based upon requirements and relative specifications and design. A number of these various outfits are described elsewhere in this issue.

Drift Prevention.—The work of the snow removal forces may be lightened and money often saved by means of some kind of drift prevention equipment or measures. The principle means employed at present include wind breaks, snow fences, and snow traps. A windbreak may be formed by planting a row of trees to the windward, well back of the roadway. Bushes or relocated stone walls will serve the same purpose. A snow fence, like a wind break, serves to cause the formation of a drift away from the road instead of on the pavement. It is placed several hundred feet to the windward of the road. Such a fence may be purchased in the form of hardwood pickets woven between wire. This form comes in convenient rolls and is easily set out in the fall and taken down in the spring. Another type, usually left in place, useful in regions of heavy snowfall, consists of a number of large wooden "sawbucks" on which horizontal boards are spiked. These are hard for the wind to upset, and if upset they function as before, due to their shape. A type used in mountain regions consists of a grid of planks that may be placed at any elevation on a line of spars. This provides for heavy cuts and can line both sides of the roadway to form an uncovered snow shed if desired. It must be remembered that guard rails interfere with plowing and cause drifts at times. In at least one state the guard rails are removed for the winter, and old chloride sacks strung on a wire and run from post to post afford a fairly effective and economical snow fence for the duration of the winter. Snow traps are used in Michigan to prevent drift formation. Snow traps are built by plowing a series of deep and wide furrows in an adjacent field after each storm. This forms a series of ridges and hollows that are reputed to catch and store the drifting snow away from the pavement. Some states build their roads on rather high fills wherever the topography permits. The wind will then keep these elevated pavements, about a foot above the surrounding ground, swept fairly clear of snow. The use of snow fence and plows will then be fairly well restricted to the cuts, in ordinary practice.

This Loader Equipment Is Useful on Heavy Drifts

Snowfall Facts as Factors.—We reproduce herewith a map of the United States showing mean snow depths, together with the areas shaded in which snow removal activity is pronounced. Another map shows the principal roads kept cleared by state forces in midwestern and eastern states. Tables 4 and 5 show government records on snowfall based on observation since 1916. These tables will show the average annual snowfall, the number of days on which snow fell, and the number of days on which the ground was covered

UNITED STATES DEPARTMENT OF AGRICULTURE

Bureau of Public Roads—Division of Construction

Table 3—SNOW REMOVAL DATA—WINTER 1926-27

STATE	Total Mileage State roads (including Fed. aid roads) surfaced with gravel or higher types of pavement as of Jan. 1, 1927	Min. and max. average annual snowfall recorded over a period of yrs. in different sections of State	Control of snow removal 1926-27	Snow Removal Equipment—Winter 1926-27					Miscellaneous Equipment		Snow Removal Winter 1926-27					REMARKS
				Truck Plows			Tractor Plows									
				Mold Board Type	"V" Type		Mold Board Type	"V" Type	Rotary Type	Trucks and Tractors	Graders	Snow Fence 1926-27	Mileage of roads with snow removed	Average seasonal snowfall from records in different sections of state	Total cost snow removal	Mileage on snow removal program for winter 1927-28	
		Inches										Miles		Inches			
NORTH ATLANTIC STATES																	
Maine	1,302	74.4 to 131.9	Townships	*	*	*	*	*	*		*	*	250	94.8	*	*	Future snow removal activities to be in charge of State through legislative enactment.
New Hampshire	1,963	65.1 to 94.0	State and Townships	16	12	6	68	....	28 Trucks 76 Tractors		4	25	** 4,680	86.1	$ 62,700	** 4,800	Mileage of roads cleaned include State and township. Total cost includes State work only.
Vermont	2,139	63.8 to 110.6	Townships	22	15	35	10	1	40 Trucks 35 Tractors		32	3	1,627	73.4	** 5,700	1,650	
Massachusetts	1,551	45.4 to 61.5	Townships	142	*	18	*	*	142 Trucks 18 Tractors	*		*	1,800	56.3	110,000	1,800	State loans part equipment. Towns remove snow. No data available on the township work.
Rhode Island	452	24.1 to 47.0	State and Townships	** 82	....	....	3	9	** 82 Trucks 13 Tractors	*		....	** 751	31.2	** 52,000	** 775	Total cost snow removal exclusive of equipment. Data for townships estimated.
Connecticut	1,819	40.3 to 75.6	State and Townships	193	....	....	7	....	183 Trucks 7 Tractors			20	1,900	41.1	174,585	1,900	Equipment includes also 15 extra snow plows.
New York	9,854	28.8 to 141.4	Counties & Townships	175	194	43	250	38	305 Trucks 211 Tractors	Numerous		700	** 15,000	70.7	** 936,000	** 15,000	Snow removal data estimated from figures submitted by 37 counties.
New Jersey	1,297	14.4 to 54.4	State and Counties	131	30	....	7	4	161 Trucks 11 Tractors		32	1	670	25.0	181,115	900	Total cost high due to all overhead included. County work data omitted.
Pennsylvania	8,439	24.7 to 92.2	State	377	107	....	85	5	484 Trucks 96 Tractors		25	235	6,300	39.8	698,000	** 6,300	
Delaware	591	16.7 to 22.9	State and County	5	7	....	5	....	23 Trucks 5 Tractors		10	2	600	10.8	10,000	650	One county only engaged in snow removal work.
Maryland	2,420	13.9 to 69.4	State	88	....	....	....	3	88 Trucks 3 Tractors		5	18	2,573	21.3	46,000	2,700	
Virginia	2,825	7.3 to 33.4	State and Counties	20	5	5	5	....	50 Trucks 50 Tractors		50	3	5,000	9.9	32,000	5,200	The equipment also includes 50 horse-drawn V-plows.
S. ATLANTIC STATES																	
West Virginia	1,732	8.8 to 101.0	State and Counties	11	....	1	....	....	44 Trucks 16 Tractors		34	....	** 422	25.4	** 9,853	** 422	Data for former winter used.

Table 3 (Continued)—SNOW REMOVAL DATA—WINTER 1926-27

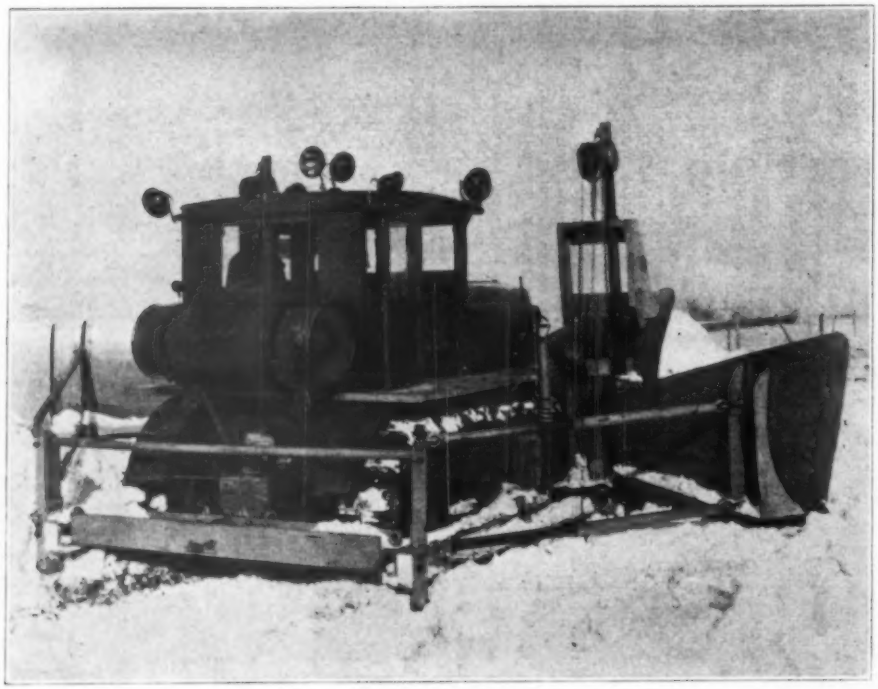
UNITED STATES DEPARTMENT OF AGRICULTURE

Bureau of Public Roads—Division of Construction

	STATE	Total Mileage State roads (including Fed. aid roads) surfaced with gravel or higher types of pavement as of Jan. 1, 1927	Min. and max. average annual snowfall recorded over a period of yrs. in different sections of State	Control of snow removal 1926-27	Snow Removal Equipment—Winter 1926-27					Miscellaneous Equipment		Snow Removal Winter 1926-27				REMARKS
					Truck Plows		Tractor Plows									
					Mold Board Type	"V" Type	Mold Board Type	"V" Type	Rotary Type	Trucks and Tractors	Graders	Snow Fence 1926-27	Mileage of roads with snow removed	Average seasonal snowfall from records in different sections of state	Total cost snow removal	Mileage on snow removal program for winter 1927-28	
			Inches									Miles		Inches			
NORTH CENTRAL STATES	Ohio	9,591	16.8 to 34.8	State and Local	150	32	6	9	6	525 Trucks 191 Tractors	396	80	5,169	20.9	143,142	7,000	Data covers State work only.
	Indiana	4,153	13.6 to 61.3	State and Local	8*	15	....	2	....	624 Trucks 49 Tractors	230	....	3,590	25.8	32,510	3,600	Equipment also includes 28 wooden plows. Data overs State work only.
	Illinois	4,496	11.6 to 39.4	State and Counties	166	43	....	2	3	224 Trucks 55 Tractors	53	....	3,891	22.8	176,874	3,891	
	Michigan	6,229	38.5 to 121.4	State and Local	176	143	2	57	43	330 Trucks 108 Tractors	Numerous	169	5,705	56.2	283,502	6,612	
	Wisconsin	8,329	24.9 to 78.3	Counties & Townships	12	24	....	27	1	31 Trucks 21 Tractors	....	132	2,619	47.8	47,226	2,620	
	Minnesota	6,246	24.0 to 54.4	State and Local	10	63	16	56	5	107 Trucks 74 Tractors	4	284	5,000	43.5	664,673	7,000	Data covers State work only.
	Iowa	3,470	21.2 to 38.1	State and Counties	14	103	....	13	5	245 Trucks 122 Tractors	1,026	345	6,650	25.2	410,338	6,650	Total cost included cost of snow fence and large expenditures for equipment.
	Missouri	3,376	6.7 to 34.2	State	20	4	....	20	....	50 Trucks 40 Tractors	30	20	1,200	15.7	4,097	1,200	Snow removal during winter 1926-27 was not a serious problem.
	North Dakota	1,335	25.0 to 45.2	State	....	....	....	3	1	3 Tractors	300	10	2,500	37.4	20,000	3,200	Snow removal done generally with horsedrawn graders.
	South Dakota	2,447	18.7 to 97.7	State and Counties	....	25	....	14	....	60 Trucks 50 Tractors	500	50	3,000	46.7	60,000	3,500	Snow removal work done by counties under State control.
	Nebraska	2,320	4.0 to 72.4	State	....	4	1	10	....	185 Trucks 127 Tractors	188	278	6,000	36.9	28,970	6,000	Total cost of snow removal work includes part of winter only.
	Kansas	1,002	8.8 to 29.2	State and Counties	15	25	60	25	....	30 Trucks 125 Tractors	1,200	125	9,190	14.3	** 125,000	13,000	The equipment also includes 100 locally-made snow plows.
	Montana	927	15.5 to 270.9	Counties	*	*	*	*	*	*	*	*	*	56.7	*	*	Snow removal work done by counties only, with data unavailable.
	Wyoming	929	9.2 to 219.7	State	....	1	....	1	....	10 Trucks 10 Tractors	....	5	100	73.4	13,662	** 100	Definite program for season 1927-28 not formulated.
WESTERN STATES	Colorado	3,489	12.8 to 276.5	Counties	*	*	*	*	*	*	*	100	4,312	80.8	50,521	4,400	
	New Mexico	1,685	5.3 to 138.4	State	*	*	*	*	*	*	*	....	*	27.6	*	*	Open winter; little snow removal work done. Maintenance equipment used.
	Arizona	1,422	0.4 to 83.0	State	....	....	4	....	....	20 Trucks 4 Tractors	20	....	412	14.9	** 5,000	412	
	Utah	1,190	5.0 to 155.1	State	14	6	6	1	1	12 Trucks 12 Tractors	....	11	1,250	51.2	40,000	1,350	
	Nevada	1,013	0.6 to 87.0	State and Local	....	2	....	....	3	4 Trucks 3 Tractors	3	2	36	31.4	1,970	54	Data covers State work only.
	Idaho	2,358	1.0 to 207.0	State and County	8	1	3	8	12	34 Trucks 12 Tractors	16	2	659	55.6	18,144	815	
	Washington	2,607	3.8 to 252.3	State and Counties	70	....	7	5	2	140 Trucks 14 Tractors	50	3	2,216	58.6	44,980	2,135	
	Oregon	3,220	1.4 to 338.6	State	44	....	15	1	5	90 Trucks 25 Tractors	50	9	1,133	44.7	130,000	1,133	Local authorities cleared 30 miles of road not included in data.
	California	3,538	1.0 to 783.0	State and Local	7	....	8	....	2	14 Trucks 14 Tractors	14	1	316	110.8	22,475	320	
	Total	111,756			1,966	861	236	684	149	4,365 Trucks 1,600 Tractors	4,272	2,633	106,721		$4,641,037	117,109	

* Asterisk indicates information not available. ** Double asterisk indicates data estimated.

NOTE: The above data is compiled from reports by the States in answer to questionnaire submitted by the U. S. Bureau of Public Roads. Snowfall figures compiled from U. S. Weather Bureau Records.



A "V" Type Tractor Plow Used Against Heavy Drifts

Table 4.—Average Snowfall (From U. S. Department of Agriculture)

State	Average Annual Snowfall in Inches for Entire States	No. of Days With Snow	Days Snow	With Cover
Maine	85	**	50	120
Vermont	70	**	50	120
New Hampshire	70	**	50	120
New York	65	*68.7	50	105
Michigan	57	*58.0	52	95
Wisconsin	47	*48.5	45	100
Minnesota	38	*40.9	51	100
North Dakota	30	*35.5	50	110
Massachusetts	45	**	52	90
Pennsylvania	50	*38.9	39	55
West Virginia	47	*32.8	40	45
South Dakota	30	*43.1	35	60
Connecticut	35	**	25	60
Iowa	28	*25.8	25	60
Rhode Island	34	**	25	59
Ohio	30	*25.5	25	45
Nebraska	28	*31.6	25	45
Idiana	27	*20.6	25	45
Illinois	26	*18.8	25	45
New Jersey	29	*27.5	25	20
Missouri	20	*15.3	15	32
Maryland	25	***	15	20
Kansas	15	*16.7	15	28
Virginia	15	*14.9	15	20
Kentucky	15	*13.8	15	20

*Average for past 12 years from U. S. Climatological Data.
**Average for past 12 years from U. S. Climatological Data; combined average 67.5 in.
***Average for past 12 years from U. S. Climatological Data; combined with Delaware, 24.9 in.

with snow. The cost of snow removal will depend not only on the cost of equipment and of labor involved, but will depend as well upon depth of snow, frequency of fall, drafting, wind, temperature, and other factors as well. These records are therefore of importance as well as of interest.

The following information secured from the states named, will give an idea of the conditions encountered in each state, the equipment used, the methods and policy involved, and in some instances the mileage covered and the cost.

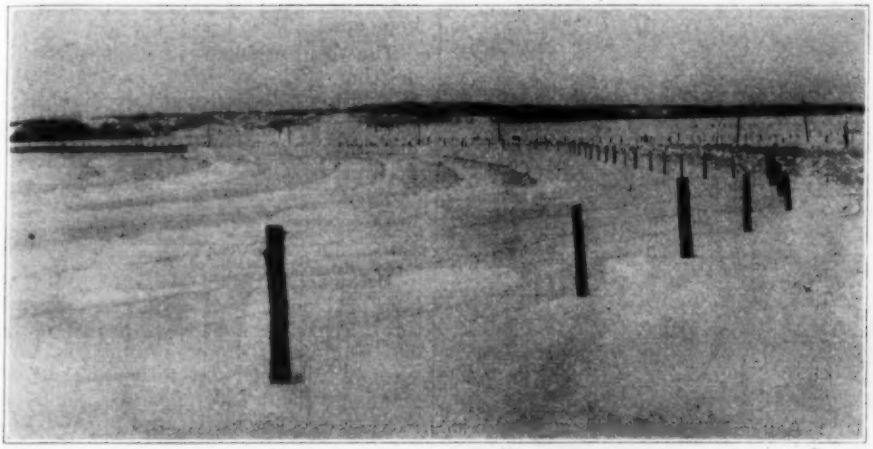
Connecticut.—The snow-removal work of the Connecticut State Highway Department is controlled by eleven district supervisors under a superintendent of maintenance, according to H. G. McKelvey, of the U. S. Bureau of Public Roads, in a recent report. Each district organization is composed of the necessary foremen, men, and equipment. The highly efficient personnel has been instructed to begin snow removal as soon as the roads have become covered to a depth of two inches. This amount of snow starts the organization to work automatically, without any further instructions from headquarters. The men assemble, according to a predetermined plan, at the various storage sites of the equipment; and if any fail to report for duty on time, it means the loss of their position with the highway department, unless they are able to give a reasonable excuse for their absence.

The equipment consists of 183 trucks, of various models and makes, scattered over the state at strategic points. These trucks are equipped with straight-blade plows. The state also has 7 V-plows operated by tractors. The straight-blade plows are used for light work and the heavy V-plows for the removal of drifted snow.

The location of each outfit is recorded, with large flat-headed pins on a state map hung on the wall of the headquarters office. On each pin there is a number which indicates the make, power and condition of the truck, and the description of the plow attachment. The equipment allotted to the various districts is intended to be adequate for normal conditions, but it often happens that a heavy snowfall, which exceeds the capacity of the equipment, occurs in one district, while the surrounding regions are affected by little or no snowfall. In this case the personnel of the snow-free districts are directed by the superintendent to proceed to the assistance of the crews in the heavy-snowfall area. This help is not delayed until the overtaxed district is snowed in, but careful watch is maintained by the headquarters office, and the relief units from the surrounding districts are hurried to the scene before the local crews have lost control of the situation. As the various units are moved to their new temporary locations, the pins on the headquarters map are shifted accordingly.

Cost.—The superintendent in charge of the snow-removal work for Connecticut, who has under his supervision the efficient maintenance organization which has been previously mentioned, believes that reliable cost data are unobtainable. He claims that 12 in.

A Rotary Plow Cleaning a Mountain Highway



Snow Traps Plowed in Fields Keep Drifts Off Some Michigan Roads

of snow, falling without wind, can be moved as cheaply as 5 in., falling with wind. Consequently, any effort to arrive at the cost of removal per inch of fall is useless. It is reported that newly-fallen snow, without wind, can be moved with a truck, which with one driver is rated at $25 per day of nine hours. In order to clear a path 36 ft. wide with this outfit, it would be necessary for the truck to make four trips over a section of 13 miles, and in doing so maintain an average of six miles per hour during the nine hours work. This would bring the cost of snow removal, under such conditions, to a rate of $2 per mile per storm. Some such figures might be used for cost data per storm, but they would be unreliable for the reason that snow seldom falls without wind, and they could be used only if the snow was left undisturbed until the storm was over. Ordinarily snow removal is begun when a depth of 2 in. or more has been reached, and the work is continued until the storm is over and the section cleared. In such cases, a truck would travel much faster than six miles per hour, but it would be necessary to make more trips in order to keep the section cleared. Some figures might be arrived at to cover the cost per mile per storm under these conditions but they would vary with the duration and intensity of the storm. The snowfall may last for nine hours and deposit 9 inches of snow, or it may fall intermittently over a period of 24 hours with the same relative depth of snow to remove. The average cost of snow removal for a state or large territory is unreliable, either when estimated from depth factors or per storm. The snowfall for the season may vary from 25 in. in some sections to 75 in. in others, and these depths vary by years. The number, duration, and intensity of the storms may vary in like manner.

Rhode Island.—Snow removal on state highways in Rhode Island is handled entirely by the Highway Department of the State Board of Public Roads, according to G. H. Henderson, chief engineer. There are no county road organizations in that state. For maintenance purposes the state has been divided into five divisions, each in charge of a division engineer, and in each of which is located a divisional headquarters where maintenance equipment is stored.

During the past winter snow removal activities were in progress on the 480 miles of the constructed state highway system and the equipment consisted of 51 state trucks, 10 state tractors and 22 hired trucks, divided between the various divisions according to their mileage. Nine of the above tractors were 5-ton tractors which were equipped with push or straight-blade plows.

The scheme of operation virtually is to start with the storm and the efficiency of operation is dependent on keeping ahead of the storm. All of our trucks and tractors are equipped with plow frames early in the winter so as to be in readiness at short notice. The work of attaching the plows to the frames does not entail much labor and is done very quickly. As the storm approaches, the snow-fighting squads assemble at the various headquarters, the plows are attached to the trucks, and as soon as there are two inches of snow on the ground they start out, each on its prescribed route. If the storm is an average storm and not accompanied by too heavy winds, they are able to keep ahead of it, and when the storm is over the road is cleared for two-way traffic. The work of pushing back the snow from the shoulders in preparation for the next storm is then carried on.

In storms accompanied by blizzards when poles and trees are felled across the roads and automobiles, trucks and motor buses are stalled, the work is sometimes so delayed that the storm gets ahead of the forces and the roads become badly blocked. For these cases, last year the department purchased nine 5-ton tractors to operate rotary plows in the belief that they would enable the department to open up the highways to traffic in a much shorter period of time than by the use of trucks and hand shoveling.

Last winter for the first time the department installed snow fence at points along the state roads where drifting had usually occurred. In all, the fence erected would total approximately two miles. As there were no serious storms the department did not have an opportunity to obtain any definite results from its use.

Their expenditure for snow removal, exclusive of equipment, during the year 1927 was $35,789, of which approximately 80 per cent was for labor, foremen and drivers.

During the coming winter the department expects to have an additional thirty-five miles of new state road in the snow removal program, which will make a total of approximately 515 miles throughout the state.

New York.—The State of New York makes no appropriation for snow removal work and claims no jurisdiction in the matter. Such activities are entirely under the jurisdiction and supervision of the local municipalities, who bear all the expense, according to

Bucking a Heavy Drift with a Tractor Outfit

Rotary Equipment Used in Nevada

David Noonan, maintenance deputy, Division of Highways, Department of Public Works.

North Dakota.—Very little snow removal work has been done by the State of North Dakota up to date. The winters of 1923-24-25 were practically without snow. Automobiles being able to travel any place in the state at any time during these three winters.

During 1926 a serious blockade of state highways occurred during the forepart of March and a great many of the roads were blocked from then until spring.

During the winter of 1927, the southern half of the state had considerable snow during most of the winter months while the northern half of the state was entirely free from snow during the entire winter.

Outside of the work done by county forces, the State Highway Commission has used only two heavy outfits on snow removal work. The patrolmen on the state highways always do whatever they can to keep their sections of highway open to traffic. When the snowfall is heavy and the winter is severe, there is more work than the patrolmen can do. The county outfits mentioned above operate in cooperation with the State Highway Commission, the county furnishing the equipment and the State Highway Commission paying the operating expenses on such equipment.

Up to the present time the State Highway Commission has not inauguarted any definite program on snow removal for the coming season. It is believed that the work will be done on the same basis as in the past two winters, namely, that 500 patrolmen will do whatever is within their power to keep their respective sections open to traffic. The small number of outfits owned by the state will work in their respective districts. Such counties as care to cooperate with the Highway Commission may cooperate on the basis mentioned above, namely, that where the county furnishes the equipment the State Highway Commission will pay operating expenses while this outfit is engaged in snow removal work on state highways under the direction of the State Highway Commission. This program will cover about 3,600 miles of main highways.

The demand is for an open road during the winter season and it is only a matter of time until the State Highway Commission will be forced to keep the highways open during the entire winter season.

Wyoming.—This state has in operation 1 "V" type snow plow operated by "30" caterpillar and five straight blade snow plows operated by trucks, according to the Highway Department.

They have not gone into snow removal very extensively as there is not the demand for it that is found in the eastern and mid-western states. The main traveled roads such as Lincoln Highway and Yellowstone Highway are kept open.

The big problem in that state is drifting. The snowfall, except in the mountains, is comparatively light and would probably never block the roads, but where conditions are favorable for drifting trouble results.

The department does not expect to purchase any more snow equipment for the coming season.

Delaware.—This state is situated so that it does not experience severe snow storms, except every 2 or 3 years, but equipment is maintained to take care of the entire state system, which numbers about 600 miles.

The state has 31 trucks and 5 tractors available for snow removal, manned with displacement plows. They have no rotary plows, as there are very few instances where deep drifts are encountered.

The entire cost of removal of snow last year was about $6,800, according to Mr. Samuel Knopf, principal assistant engineer of the State Highway Department.

Nevada.—According to Mr. S. C. Durkee, state highway engineer, Nevada, experienced during the past winter a total cost of snow removal of $8,350.45, or an average of $21.78 per mile. In this state the snow problem is not at all a serious one and this average cost holds good for the past three years. The department is in fair shape to handle the snow removal should they have a severe winter. Three King rotary snow plows are placed at advantageous points over the state highway system, one large rotary with 10-ton tractor being placed in the western part where the snowfall is heaviest, and two small rotaries in the north central and eastern sections. These are propelled with five ton tractors. They also have numerous

Rotary Bucking a Drift on a Nevada Highway

A "V" Plow in New Hampshire

"V" plows and blades which may be attached either to small tractors or to trucks. Two photographs are shown, of a rotary clearing the highway between Carson City and Lake Tahoe, near the summit of the Sierras.

West Virginia.—Snow removal in West Virginia is confined principally to the northeastern part of the state. Last winter, 961 miles of state roads were under snow surveillance, and active work was done on 711 miles. The total cost of the work on this 711 miles was $7,439.15, or $10.46 a mile.

The equipment includes two large rotary snow plows, operated by tractors, 38 trucks, 5 tractors, 32 plows operated by trucks, and 23 graders.

The method followed is substantially that of a fire department. The roads are regularly patrolled and in threatening weather, watch is kept at night. When snow starts falling and reaches a certain depth on the roads, with a prospect of more, word is telephoned to the building in which the equipment is kept in readiness to go out. Regardless of the hour, the snow crews get out immediately and continue on duty until the emergency is over. Men have worked almost continuously for as much as 36 hours.

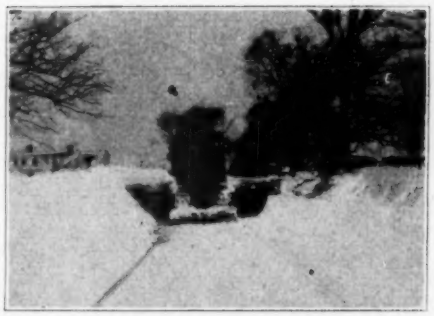
A New Hampshire Outfit in Action

It is believed that the expenditure is more than justified, and there have been many expressions of public appreciation. A four wheel drive truck with Snow King plow was recently purchased. It is probable that three more trucks with straight blade plows will be bought this fall, according to Mr. A. J. Mills, of the State Road Commission.

New Hampshire.—According to Richard W. Brown, superintendent of equipment, the policy of the State Highway Department has always been never to force snow removal upon a town or upon the people. Three years ago a law was passed by the state legislature which enabled the governor and council to designate certain main highways as roads of such importance as to demand the removal of snow. These roads are opened by the State Highway Department and the mileage plowed is held at the minimum. The law also states that a town which desires to remove snow from its roads may obtain financial aid from the state, providing such roads come within the classifications as set forth in the law. The principle of the law is very close to that set forth in our State Aid Law for the construction and maintenance of state aid highways. At first the applications for such aid came in very slowly, but today there is hardly a town in the state but what does apply for aid in the removal of snow. The department has tried to encourage the towns to purchase their own snow fighting equipment, as it is felt that the state ought not and in fact, could not purchase equipment enough to accomplish the purpose. This policy is in effect at the present time, and it is felt that it works well and that New Hampshire has good "Snow Highways."

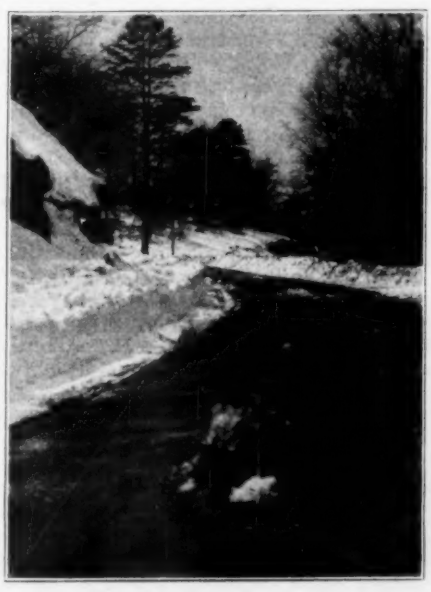
One of the New Hampshire Truck Units

Administration.—The money apportioned for snow work is set aside by the highway commissioner with the approval of the Governor and Council. The direct supervision of the snow removal work comes under the division engineer. This state is divided into ten divisions, each in charge of an engineer. The engineer gives each of his foremen charge of from 15 to 25 miles of highways, and the importance of getting out quickly and early during the storm is stressed, also the correct location of snow fence which is of vital importance in any snow removal program. Back of the actual storm fighters is the Highway Garage, an organization maintained to service the equipment during and after the storm. This garage is located at Concord which is very nearly in the center of the state. Before the snow season starts the equipment to be used is sent out in the different localities where it is housed in warm storage wherever possible, and men are available at the garage at all times during a storm, ready to go out

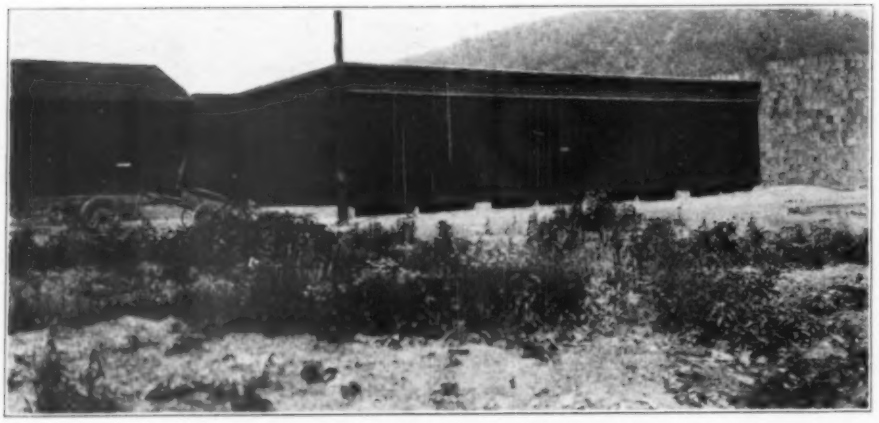


Blade Plow at Work in New Hampshire

New Hampshire Road After the Plow Has Passed



A Well Cleaned Highway



One of the Storage Garages in New Hampshire

and make any repairs necessary. In localities which are isolated, a telephone system has been used whereby the engineer may keep in constant touch with the men on the road.

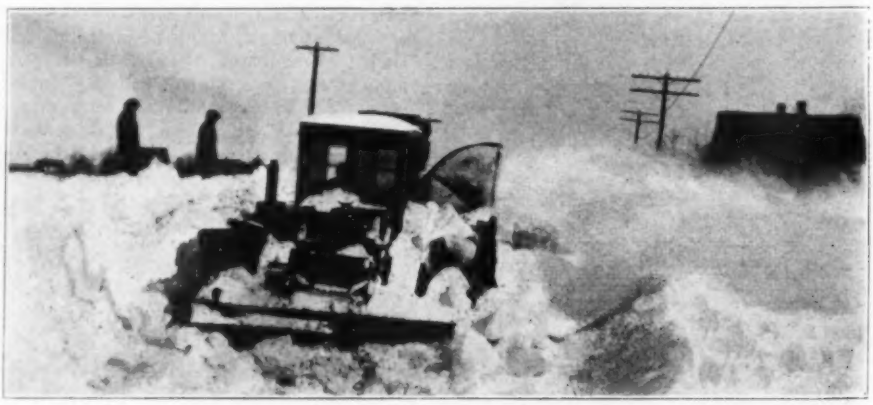
Equipment.—The proper equipment in the proper place is one of the vital needs in snow work. The problem calls for quick action in getting a road through so that travel is not held up. The state is successful in doing this, and gives the public using the highways satisfaction. The first year the state plowed snow, it was thought necessary to have heavy tractors to do the plowing, but it was found that these machines were too slow to care for the sections allotted them, and today about 75 per cent of the plowing on the main highway is done with trucks. Speed plays an important part in removing snow. These trucks are equipped with a Frink steel "V" plow known by some as a railroad type. Some of the trucks were equipped with the steel blade plow which works very well in light snow, or when the forces want to clean up the road. Both types are necessary. At the present time the state does not have a rotary plow as no locality kept open demands such a plow. The snow fleet consists of the following machines: One ten ton Linn tractor, six cylinder, one ten ton Holts, full crawler tractor, and two Lombard seven ton tractors. The department favors the type of tractor such as the Linn and Lombard, sometimes called a tractor truck because it has a body and hoist, and therefore can carry a load as well as pull one, and these features make it more nearly a year round proposition than the full crawler type, although they like their Holt very much. For trucks, they operate twenty-five of the U. S. Army Liberty class "B," rated at 3½ tons capacity. These trucks are loaded not to exceed three tons. Last season about 500 miles of our main trunk lines were opened with the above equipment at an average cost of $65 per mile.

Pennsylvania.—According to F. H. Mason, purchasing agent, of the Department of Highways, this state maintained snow removal activities on a little over 8,400 miles of state highway last winter at a cost of about $850,000, or a unit cost of a little over $100 per mile. The mean snowfall for the state was about 41 in., thus giving a cost per mile per inch of snow of about $2.50. This cost included all such things as snow fence, wind breaks, and the use of cinders on steep hills. In that year the state used 600 trucks equipped with snow plows, 93 tractors equipped with push plows, 19 tractors equipped with rotary plows, and one snow loader, as well as about 300 miles of snow fence. For use this winter, to replace trucks that have been found unserviceable since last spring, the state has purchased 76 four wheel drive trucks for the coming season, and a number of plows will be purchased before the end of the year.

Policy.—The keynote of the situation, in the consideration of the department, is that snow removal must be started when the snow starts falling, rather than after the roads have become blocked. The equipment is put to work as soon as 2 in. of snow has fallen, and stays on the job until the storm is over and there is no longer any danger of the roads becoming blocked. To maintain this policy, the state is divided into eight divisions, or districts, each under a division engineer, and each such engineer having under him from five to eight maintenance superintendents. Each of these has jurisdiction over one large county or several small counties, and these work units are so distributed that each is of a size small enough to be overseen by one man, with a total of 52 of these county units provided for in the scheme of organization. A total force of 2,000 men are on the list for call when the snow starts, and the various groups are called on the telephone and ordered to report whenever the superintendent considers it necessary. Since they must work con-

Table 5.—Average Snowfall in Snow-Belt States (East of Rockies)

	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	Ave.
Colorado	109.2	77.1	78.0	79.0	77.2	90.8	107.5	103.0	107.1	59.1	84.7	79.0	86.9
Idaho	107.0	87.1	44.7	71.9	46.0	64.4	82.2	53.7	45.6	39.5	42.0	62.1	62.2
Illinois	20.8	18.2	26.7	12.7	19.4	10.3	9.1	12.3	27.3	17.9	33.3	17.4	18.8
Indiana	26.3	30.7	28.2	7.9	24.9	12.2	11.7	12.0	28.5	16.3	29.2	18.5	20.6
Iowa	29.5	32.4	33.4	26.6	21.7	20.7	13.5	18.0	37.2	29.2	27.8	17.9	25.8
Kansas	19.1	8.7	25.5	19.2	11.5	10.1	12.8	9.3	37.6	11.3	21.0	14.4	16.7
Kentucky	23.9	42.8	24.9	3.7	10.1	13.0	3.0	3.9	6.3	10.1	13.1	10.5	13.8
Maryland and Delaware	28.5	35.7	31.4	11.9	20.0	20.5	34.8	22.0	30.5	23.0	24.6	15.3	24.9
Michigan	61.6	56.8	56.2	49.8	57.8	44.9	50.0	70.7	71.8	50.8	78.3	47.5	58.0
Minnesota	54.2	53.5	27.8	44.3	40.6	31.1	47.0	37.5	35.7	27.0	45.7	46.6	40.9
Missouri	19.0	13.7	10.0	10.7	15.4	11.5	8.5	14.0	29.4	16.4	22.9	12.7	15.3
Montana	79.0	73.6	49.0	63.5	42.6	55.7	62.7	46.4	55.6	49.8	45.8	73.0	58.0
Nebraska	34.3	32.1	34.2	42.9	36.8	20.5	22.4	28.5	44.7	26.0	21.7	35.0	31.6
Nevada	67.2	29.8	34.2	52.7	45.7	30.7	48.8	29.0	32.8	21.5	19.5	33.7	37.1
Me., Mass., N. H., R. I., Vt., Conn.	90.3	74.4	62.2	41.5	94.3	54.3	71.8	62.4	58.9	60.0	82.8	57.5	67.5
New Jersey	49.6	40.4	25.3	10.9	33.4	23.0	30.8	39.8	24.3	26.8	32.2	13.7	27.5
New York	92.0	70.0	58.4	45.1	85.6	42.1	62.4	77.1	58.7	74.3	88.4	58.2	68.7
North Dakota	55.5	41.6	41.6	49.8	27.9	29.4	42.8	30.0	28.5	19.7	22.7	36.2	35.5
Ohio	35.2	43.3	30.2	10.3	30.4	16.0	17.7	16.3	28.0	22.0	38.8	18.1	25.5
Pennsylvania	52.8	45.6	35.0	24.1	41.7	30.9	38.5	30.0	44.7	30.0	49.8	30.4	38.9
South Dakota	47.6	53.2	53.2	56.2	49.8	32.9	48.7	28.1	43.6	26.1	29.3	48.3	43.1
Utah	80.3	53.8	50.6	61.1	68.6	51.1	86.2	57.1	63.5	29.2	38.7	54.8	57.9
Virginia	18.6	23.7	24.7	7.4	7.1	13.8	24.8	10.3	12.8	9.5	16.5	10.4	14.9
West Virginia	43.9	54.6	37.7	16.8	25.7	22.4	25.8	23.9	36.1	31.1	49.4	26.6	32.8
Wisconsin	46.7	56.4	49.1	41.2	50 9	39.4	38.0	65.7	51.1	34.2	66.2	43 2	48.5
Wyoming	88.8	87.8	72.9	68.7	75.7	58.5	72.7	70.4	67.6	50.6	48.3	67.6	69.1
Average	48.0	47.6	40.2	35.8	40.8	29.2	41.3	38.1	42.5	31.2	41.2	36.5	



A Rotary Plow at Work in a Heavy Snow

tinuously until the end of a storm without regard to the time involved, these men are paid for whatever overtime they put in.

Each of these 52 administrative units contains one or more garages where equipment is kept in readiness at all times, thus making it possible to start the patrols whenever needed. A watchman is on duty at these points day and night throughout the season. Reserve equipment and special equipment not always used is maintained in working order at these points at all times.

Oregon.—According to Roy A. Klein, state highway engineer, of the Oregon State Highway Commission, snow removal must be governed by the volume of traffic which can be expected to use the highways during the winter months, and the cost of keeping the road open to such traffic. Each local condition in this respect is a separate problem.

Inasmuch as "an ounce of prevention is worth a pound of cure," it is much better whenever possible, to eliminate the necessity of snow removal by judicious location of highways, avoiding high passes and keeping the route in good exposure. The lee side of the slopes in wind-swept districts should also be avoided. Through valleys subject to drifting snow, the grade line should be kept well above the surrounding fields so that the roadway will be swept free from snow.

Investigations are made of the cause of drifts, which are often due to the accumulation of weeds and brush by the roadway, or by board fences or gates, and the removal of these will many times alleviate the condition. In cases where a cure cannot be effected by these means, it is necessary to control the formation of the drift by means of snow fences. The intelligent use of snow fences in windy districts will accomplish more per dollar expended than any other feature in maintaining the highways free from snow.

The most economical equipment for snow removal is the mold-board plow mounted in front of a truck. It is fast and covers a large amount of ground and is very effective in removing snow up to about sixteen inches in depth.

A Plowed Highway in Oregon

For greater depths, the rotary plows are much more effective. Both types are used in Oregon. The use of tractor equipment has been discontinued because it damages macadam roads to such an extent that reconditioning and even resurfacing will prove necessary each spring. In some sections of the state there is a demand to leave a small layer of snow on top of the pavement or macadam to facilitate the operation of sleds which come from side roads. However the traffic on the layer of snow soon forms an ice crust which is very hazardous, especially to the motor traffic. To accentuate this hazard, small ruts are formed making it very dangerous for passing vehicles. Moreover, as the frost leaves, the macadam surface absorbs the water, which results in a super-saturated condition, causing the macadam to cut through, thereby inconveniencing traffic and causing material damage to the road.

During the season of 1928-9, the following equipment will be used in snow removal operations: 55 mold-board truck plows, 4 rotary-type plows mounted on ten ton tractors, 6 rotary plows of the heavy truck types, and 8 "V" type attachments for motorized graders.

An effort was made, in as far as possible in the past, to convert the ordinary patrol equipment, such as trucks and graders which were employed on routine work throughout the remainder of the year, into an effective snow fighting outfit. The graders were not very serviceable, due to the motive power being handicapped by the snow, but the inexpensive mold-board plow, mounted in front of trucks, was very effective.

The modern method in snow removal is to remove the snow as fast as it falls, permitting the use of light, fast equipment, therein insuring an open road.

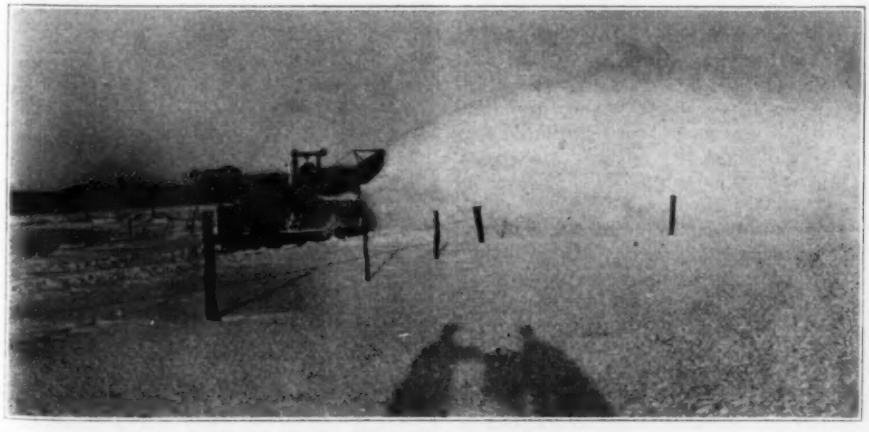
In certain places, as for instance Hood River, snow plows were held to use in snow blockades, which, due to the light winter, did not materialize. If one heavy fall develops, so much equipment is required that it is essential to have immediately available, equipment to clear the snow on such important arterials as the Columbia River Highway. In these cases, the only expense incurred was the department rental for depreciation of the equipment.

Needless to say, it is very important to keep the drainage properly functioning and to this end, the location of culverts are marked by high stakes so that the culverts can be easily found and opened at the proper time. Stakes are also placed along the edge of the roadway so that the shoulders of the grade are well defined for the guidance of the operators of the snow plows during storms.

In western Oregon, the only extensive snow removal operation is over the eleven miles of the Pacific Highway through the Siskiyou Mountains. Snow is removed in this section by two new F. W. D. trucks equipped with 10-ft. mold-board plows. The removal of the snow through the Siskiyou Mountains affords a clear artery of traffic through the states of Oregon, Washington and California, and its importance cannot be minimized.

In eastern Oregon, the major snow condition is through the Blue Mountains where the snow falls to a depth of from three to ten feet. Two truck plows and a large ten ton tractor. equipped with a rotary plow, and one truck rotary, are used to keep the Old Oregon Trail in this section open.

Other sections which are kept clear of snow are the Ashland-Klamath Falls Highway, the Dalles-California Highway, Ochoco Highway, the Columbia River Highway, and the Old Oregon Trail. Although the Columbia River Highway is subject to only occasional snow storms, on account of its importance as a main artery of traffic between eastern and western Oregon, equipment is stationed at Hood River to handle the snow in case an emergency arises. No attempt has yet been made to clear the snow from the extremely high mountain passes such as are on the



Rotary at Work on Oregon Highway

Mount Hood Highway, the McKenzie Highway and the Crater Lake Highway.

The expenditures for 1928-1929 season are very indefinite. The expenditures for the 1927-1928 season were around $125,000; $40,000 of which was an equipment charge for plows, tractors and trucks.

The department has under consideration the purchase of only two additional plows this year. These are to be of the truck rotary type and, inasmuch as the order has not been given, it is not possible to say just what will be purchased. Experience in the last few years has led them to change their ideas concerning snow-fighting equipment from heavy, slow moving equipment to lighter equipment with a higher degree of mobility. As fast as their present tractor units are retired on account of obsolescence, they will be replaced with truck units capable of doing the same work, but having the advantage of a higher degree of portability and in that they will not damage roads in their operation.

Nebraska.—Last season in the Nebraska district administered by F. C. Rolls, district engineer for the Bureau of Roads and Bridges, which comprises 12 counties through practically the center of the state, they had practically no snow. In order to protect approximately 800 miles of state highway the state erected 52½ miles of slat snow fence. This is placed along the north side of east and west roads approximately 75 feet from the fence line. Practically all of the trouble is on the east and west roads for the reason the prevailing winter winds are from the north west.

The snow fence method of snow prevention has worked very successfully in this district, in fact, so well that only one large "V" type snow plow is maintained in the whole district. The cost of erecting this snow fence is not big for the reason that the regular patrolmen start work on this early in the fall when they can be spared from the road. Some of this fence has been used four seasons and it apparently shows no sign of deterioration.

Colorado.—According to L. D. Blauvelt, State Highway Engineer, the topography of Colorado is such that a majority of the mountain passes are closed during the winter months. In the valley part of the state the maintenance crews will remove the snow with the ordinary maintenance equipment. Heretofore this work has been done by the counties.

Another Well Plowed Highway

Tractor Plow in Heavy Drift

Washington.—The Highway Department of the State of Washington, according to Samuel J. Humps, State Highway Engineer, removed snow from 2,293 miles of highway at a cost of $53,000.00, the snow being removed to an average width of 18 feet.

The following equipment was used in the snow removal:

Rotary snow plows	3
Tractors with plows	11
Trucks with plows	66

Indiana.—The Indiana State Highway Commission, according to A. H. Hinkle, Supt. of Maintenance, has direct charge over the roads in the state highway system while the counties, townships and cities have charge of their own roads. The state highway commission provides for continual maintenance on all of its roads including snow removal. The counties, townships and cities provide for maintenance on their roads as needed.

Records show that the state cleared 2,837.84 miles of its roads of snow; on January 1st, 1928, there was 4,363.64 miles of roads in the state highway system.

Under date of September 30th, 1927, the state highway commission had 671 heavy trucks and 137 light trucks in service in the maintenance division. Most of these trucks were available for snow removal work on the state roads as the occasion demanded.

Last winter the state highway commission had 41 commercial snow plows for mounting on trucks. In addition there were many home made plows used with trucks. No rotary truck plows are used. The state highway commission also had 115 tractors in service in the maintenance division on that date. Most of these tractors were available for snow removal work as the occasion demanded. Two "V" type or displacement plows were available for mounting on these tractors.

The commission also had 259 graders, most of which were available for snow removal work as the occasion demanded. No snow fence was in use.

During last winter the state highway commission spent $18,668.50 on snow removal to which should be added the cost of equipment. This cost of equipment is not available.

Virginia.—According to C. S. Mullen, Chief Engineer, Department of Highways, Commonwealth of Virginia, his department removes the snow from the entire state system of about 5,000 miles. They use for doing this work 15 snow plows attached to trucks, 10 snow plows attached to tractors and 70 graders. The forces begin removing snow when it is to the depth of one inch regardless of what time of day or night it falls.

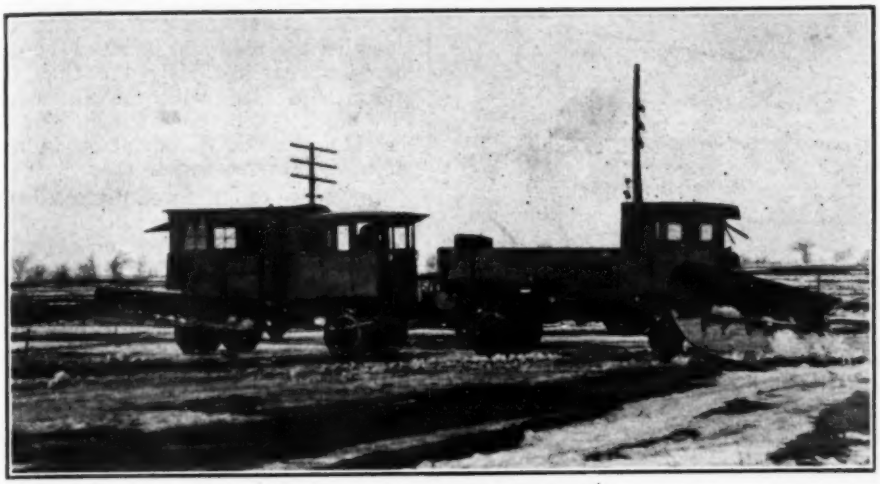
Vermont.—According to W. L. Carpenter, Chief Clerk, Vermont State Highway Board, the snowfall was exceptionally light in Vermont, and the cost of snow removal on main line highways amounted approximately to $33,500.00, this of course being financed by the towns and claims filed with the state highway department in the spring on which the state reimbursed the towns, the state's share not to exceed one-half the cost of the work and in no case to exceed $35.00 per mile. Consequently, the cost to the state on the work mentioned above amounted to approximately $17,000.00.

Approximately 1,900 miles of the main line highways were kept free of snow in 220 towns and villages of the state.

He expects the mileage this season will run the same as last winter, and if they have an ordinary amount of snow fall, the expense will be somewhat greater than that of last season.

Wisconsin.—George B. Hank, Assistant Maintenance Engineer, Wisconsin Highway Commission, writing for J. R. McLean, Maintenance Engineer, reports 179 crawler type tractors, 211 motor trucks, 75 tractor plows, 117 truck plows, and 6 rotary plows in the hands

Heavy Snow Fence Used in Minnesota



Tandem Truck Unit Used in Minnesota

of the counties, available for snow removal work. The counties also reported for the season 1927-28, 162,745 lin. ft. of snow fence on hand, 4,190,960 ft. required to keep the state trunk highways open and 3,750,160 ft. to keep the county trunk highways open, and 683,660 lin. ft. of snow fence to be purchased for the season. During the last season 4,973.85 miles of state trunk highways and 4,074 miles of county trunk highways were to be kept open. For this work, the total funds available amounted to $97,424.18, according to the report, which did not, however, account for all funds actually expended for the purpose. Costs ranged from $12 to $50 per mile. Apparently an average cost would be from $25 to $30 per mile.

The matter of snow removal is entirely in the hands of the county officials. The state does not take any part in it, nor does it furnish any funds with which to carry on this work. However, it is believed that it will only be a matter of time when the legislature of Wisconsin will provide state funds with which to carry on snow removal work. County officials generally admit the necessity for snow removal work, but some feel that the state should be responsible and defray the cost.

Minnesota.—According to W. F. Rosenwald, Maintenance Engineer, Minnesota Dept. of Highways this department will continue the policy of keeping the entire state trunk highway system open throughout the winter. This policy was adopted two years ago in order to meet the demands of the ever growing volume of traffic which is now using the highways in the winter, as well as in the summer time, and which is increasing so rapidly since the development of the motor vehicle as a means of transportation.

The traffic on the Minnesota highways is now of as great a volume in the winter as it was during the summer only a few years ago, and it is now as necessary to keep the roads passable in winter as it was to keep them passable in the summer a few years ago.

Design of Road.—The snow problem is of course affected by the manner in which the road is constructed and by arrangements for controlling the formation of drifts.

Where possible the road should be so constructed that the snow is carried entirely across the road. In designing the road it must be borne in mind that any construction or formation which will set up eddies in the air moving over the road will cause the formation of a drift. Wind has a snow carrying capacity which varies with the velocity of the wind. The velocity is affected when the wind comes in contact with obstructions, consequently we are principally concerned with the snow which is carried by the strata of air in contact with the ground. This amount of snow is but a small portion of the snow in motion, but it is enough to cause all the trouble. In this connection study can well be made of velocity curves and slopes with a view to securing a road cross section which will permit the air to move with uninterrupted velocity. It is, of course, complicated by the wide variation in wind velocities. The action resembles somewhat that of water moving over a dam but in that case the movement is comparatively much more constant.

Snow which is not carried over the road is deposited and this presents the problem of providing storage space for the snow which is dropped from the portion of the stream of air in contact with the ground and other obstructions. Naturally, the greater the storage capacity the longer it will take the wind to fill it. This explains why a shallow cut is always more rapidly and completely blocked than a large deep cut.

Snow Fence.—The erection of snow fence is merely a means of increasing the storage capacity. A cornfield or other vegetation will act in the same way and store snow in drifts. The position of the fence or obstruction controls the location of the deposit or drift.

The snow fence is the most convenient way of providing controlled snow storage but it was expensive until the picket fence was applied for the purpose.

The old A type fence made of boards cost from 50 to 75 cents per foot, was bulky and hard to handle and the maintenance of it was expensive. The picket fence made of wooden slats woven together with wire costs from 10 to 12 cents a foot, including posts, comes in compact rolls and is easy to erect, take down and handy for storage.

It is often possible to improvise obstructions which will serve if fence is not available. A row of brush stuck in the snow, blocks of snow piled up and even plow furrows of dirt or snow will help. An uncut cornfield on the windward side of the road is most effective.

The position of a snow fence is on the side of the road towards the direction of the prevailing winds, ordinarily about 100 feet from the road. The distance depends somewhat upon the

Tandem Outfit Working on Typical Snow Fall

Four Wheel Driven Truck with a V Plow

normal velocities of wind. In open prairie country the velocities are usually greater and the distance out is necessarily increased. The direction of prevailing winds is also often variable and it may be necessary to place fence on both sides of the road or in some places to put sections of fence in a staggered position.

If the fence is placed about 6 in. above the ground the wind passing under it will prevent the snow fence becoming buried and it will function longer, or if need be it can be raised without the necessity of digging it out.

The best position of snow fence can only be discovered through experience in the particular locality, and no hard and fast rules can be laid down. The location of the drifts must be studied, possibly the position of a snow fence changed, but always the situation must be carefully noted for future guidance.

It is possible in the design of the road and by means of well placed fence to largely reduce the formation of drifts in a troublesome position, and the removal of the snow which falls on or collects on a road is a much easier matter thereafter. However, all preparations can easily be nullified if the weeds and other tall vegetation along the road side is not removed before the snow comes. Clumps and even single weeds can cause no end of trouble and, therefore, they must be removed before the trouble starts.

Organization.—The Minnesota system of trunk or state highways is divided into sixteen maintenance districts of approximately 400 miles each, with an experienced highway engineer as superintendent in charge in each district. Each district has a complete organization of men and equipment with shop facilities to repair equipment. The construction of a fully equipped shop building has just been completed in each district. This building also contains the district office and is the headquarters for control of operations in the district.

The typical district is subdivided into sections of from 20 to 30 miles with a sectionman responsible for each. He has a helper and a truck of 2½ to 3 ton capacity, capable of traveling 25 to 35 miles an hour when loaded and of sustained heavy duty operation at slower speeds. About ¼ to ½ of the sections are equipped with trucks of the four wheel drive type. Each truck is equipped with a fairly light snow plow and during the lighter storms is operated alone. However, as the snow becomes more difficult, the trucks on adjoining sections are coupled together and operated as a tandem unit with a heavier snow plow. At least every other truck is equipped with a side wing and all trucks are so equipped with hitches that they are interchangeable.

In some cases the men have combined three trucks, but this is not economical or practical and is discouraged.

For Heavy Snow.—As the winter progresses and the snow becomes more difficult, it often becomes too hard for the two wheel drive trucks, and consequently, it becomes necessary for the four wheel drives to assist on the sections which happen to be in difficulty. At times it is even necessary to call on the crawler type tractors and rotaries to break open or clean up a road, but this is a last resort which is very expensive, and can be largely avoided if the advance preparations for controlling the formation of snow drifts have been thorough, and if the early plowing operations have been well carried on and properly cleaned up.

His department does not ordinarily advocate the operation of snow plows during a storm, as the chanecs are that it will only increase the depth of the snow on the road and increase the difficulties generally. By the time the storm is over and when the most effective work can be done the men might be exhausted and the equipment in need of a visit to the repair shop.

In wooded or other well protected sections where a road is protected against winds there is, of course, no objection to plowing during a snow storm.

Opening the Road.—When opening up a road the snow must be thrown back and with as little ridge as possible. A ridge on the windward side is much more serious than one on the other side, and consequently, the first opening through should be on the side from which the prevailing winds come. In many cases a strong wind will actually help to remove the rest of the snow. The faster a snow plow is operated the further the snow will be thrown and the less difficulty there will be from ridges or in the clean up.

As a snow storm lets up the opening up should begin and operations should not cease until the snow has been removed over the entire width of the roadway and shoulders, and if possible, beyond the ditches.

The more narrow the opening is, the more limited will be the snow storage capacity and consequently the more easily and rapidly will the road fill up.

Type of Plows.—The snow plows are all of the V shape and those on the trucks are designed for operating speeds up to 30 miles an hour and even higher. The wings are attached to the pusher truck in the tandem units.

At least one rotary type plow is available for each district. A few special trucks are also available, on four wheel drives with powerful motors capable of high speeds, and at the same time powerful enough to penetrate with practically the power of the largest tractors. This special equipment, which is very mobile, is operated as a special reserve and is transferred to the areas which may need the help. The mobility of all the equipment makes it possible to readily concentrate operations in a troublesome area by drawing

Five Ton Tractor Widening After a Storm

on the equipment from the areas where the difficulties are lighter.

All the district offices are equipped with recording barometers and the superintendents become quite good weather forecasters, with the result that they are in a good position to determine the times when to hold in the equipment or when to start it out.

When Work Starts.—The highway traffic always starts moving after or during a storm as soon as it possibly can. This presents another problem and the forces must use every precaution to avoid accidents. Consequently, the various units are made as conspicuous as possible both day and night. The ends or tips of the plows, both front and rear, are striped black and yellow and at night a combination of red, yellow and white lights are used to illuminate the various projections or parts of the unit in a manner which to some may seem extravagant. Even with these precautions the forces have occasional cases of collision.

Last winter, which started early with a number of heavy snow storms, eased off the latter part of the winter and was probably an average winter. With a few exceptions, practically the entire system was open within a day after each storm and the state spent $520,900 on their 7,000 mile system, or an average of $74 per mile.

Their first attempts at snow removal, about six years ago, were very much higher in cost, but with experience in preparation, equipment and operation the costs have reduced materially each season and there is no reason to fear this as burdensome expense.

This year the state has replaced fifty of their old trucks with new trucks and have added or replaced old snow plows with 40 new plows.

During the coming winter the state will employ approximately 230 trucks and 60 crawler type tractors. They have 14 rotaries and may employ some additional units as the necessity may develop.

Michigan.—According to B. C. Tiney, maintenance engineer, Michigan State Highway Department, that state has at the present time 7,406 miles of state trunk line roads under maintenance. During the past winter Michigan maintained for wheel traffic 6,682.7 miles of road at an average cost of $83.02 per mile. The state proposes to add to the wheel traffic program for the coming winter 359.2 miles, making a total program of 7,041.9 miles.

The general plan of winter maintenance in Michigan involves the use of the motor truck as far as this unit is able to economically perform the work. The type of truck preferred for this work is a 6 cylinder 3½ ton capacity truck with pneumatic tires and a 7 speed transmission. In the southern part of the state we use one way blade plows 10 ft. long and 20 in. to 36 in. in height mounted in front of motor

State Highway Immediately After a Storm

trucks. In the northern part of the state the "V" plow is used on these trucks. This plow is approximately 8 ft. to 10 ft. in width and 3 ft. to 5 ft. in height. The truck "V" plow is capable of going through heavier snow conditions than is a one way blade, but the latter is preferable in the lighter snow regions. The work with trucks involves the clearing of the road during storms and patrolling the surface to keep it smooth and free from ruts. When the ridge of snow which has been thrown up by the truck plows has become of such proportions that it must be thrown back, bringing into use the tractor plows, on this type of equipment, the state uses the ten ton tractor with caterpillar treads, on which is mounted either the "V" type displacement plow about 5 ft. in height and 12 ft. in width, or the Rotary plow of approximately the same dimensions. The Rotary plow is much preferred because it distributes the snow back over a distance of 30 ft. or 40 ft., rather than piling it up to a great height adjacent to the roadway, which condition promotes drifting into the roadway.

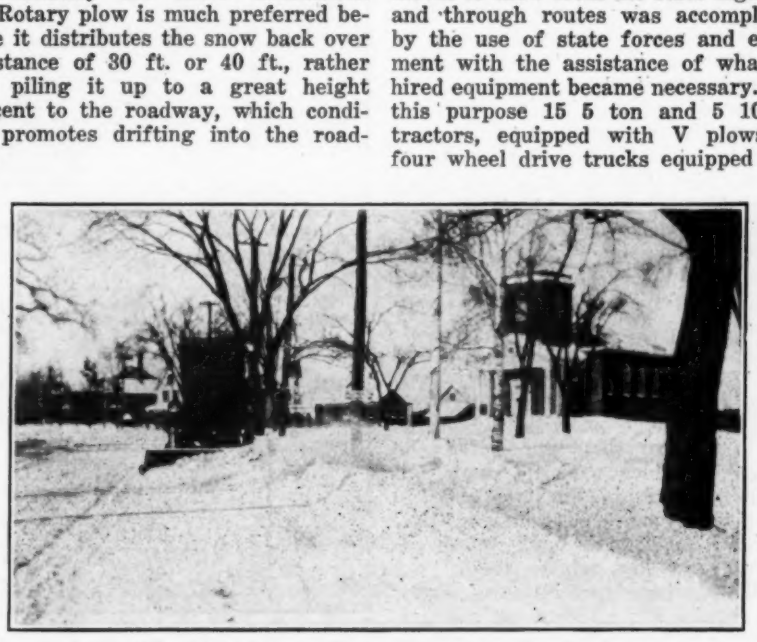
Snow fence is used very extensively in Michigan for drift control. The standard type of fence used for this purpose is the woven picket type 4 ft. in height. During the past two years the state has purchased approximately 600,000 lineal feet of fence per year, and is at the present time receiving delivery on an additional 750,000 lineal feet for next winter's work.

Iowa.—W. H. Root, maintenance engineer, Iowa State Highway Commission, states that his department keeps the entire primary mileage, consisting of 6,665 miles, open for traffic throughout the winter.

They do this first by the erection of a liberal amount of snow fence. This year they will have three million feet of snow fence erected along the primary roads. The state also has a large number of truck plows, using quite largely the "V" plows with wings, mounted on war surplus F. W. D.'s. Under difficult conditions they use a second F. W. D. for a pusher. They also have 251 heavy trucks which are available for this work and 164 truck snow plows, and also, 20 tractor snow plows of the "V" type with wings and 9 rotary plows. These plows are used for opening up through heavy drifts and for widening out roads which have been opened up with truck plows.

Massachusetts.—This state, reports A. W. Dean, Chief Highway Engineer, previous to the winters of 1927 and 1928 did all snow removal work through a co-operative method, that is, the State Department of Public Works loaned equipment, consisting of three and five ton trucks, mostly of the four wheel drive type, and blade plows to the various cities and towns in the Commonwealth on condition that they be used on state highways and through routes.

The past winter, however, the removal of snow from the state highways and through routes was accomplished by the use of state forces and equipment with the assistance of whatever hired equipment became necessary. For this purpose 15 5 ton and 5 10 ton tractors, equipped with V plows, 94 four wheel drive trucks equipped with



Four Wheel Driven Truck Plowing with Blade Plows

blade or V plows, all of which were state owned, were used, together with approximately 150 hired trucks, equipped with state owned blade plows. Seven miles of 5 ft. snow fence was purchased in the fall of 1927 and placed in position to prevent drifting on the road surface where the experience of the Department of Public Works in the past had shown this condition to exist.

A truck was assigned from four to ten miles of road, depending upon the snow conditions likely to exist along this road, traffic which would be encountered while plowing and on the efficiency of the unit. These trucks started plowing shortly after a storm commenced and continued until the roadway was entirely cleared of snow for its full width. The tractors were not assigned to a special section of road, but were placed at various points throughout the state and held in readiness for any emergency that might arise. These tractors would also be used in widening out after a storm, in order to make sufficient room to pile up snow in a succeeding storm. Following this system the roads of the Commonwealth were successfully kept open during the past winter and although the snowfall was very light, it is believed that sufficient trial was given to warrant belief that except in extremely difficult storms the highways can be kept open and in no case and under no conditions would a road be closed more than a few hours.

The following mileage of through routes is maintained by the department:

State Highway Mileage	1,258 miles
Town Highway Mileage	120 miles
Total	1,378 miles

In addition to the through routes, the cities and towns plow their own roads to such an extent that one can proceed to any point in the state without undue difficulty.

It is proposed to purchase for use the coming season seven miles of 4 ft. snow fence and four 5 ton tractors, equipped with V plows. The roads to be cleared and the mileage will be substantially the same as last season.

Illinois.—According to Frank T. Sheets, Chief Highway Engineer, State of Illinois, during 1927 his department operated for snow removal purposes the following equipment: 283 heavy motor trucks, 47 "V" type plows, 4 rotary plows, 26 caterpillar tractors, 9 tractor displacement "V" type plows, approximately 232 straight blade plows, and possibly as many as 100 road graders.

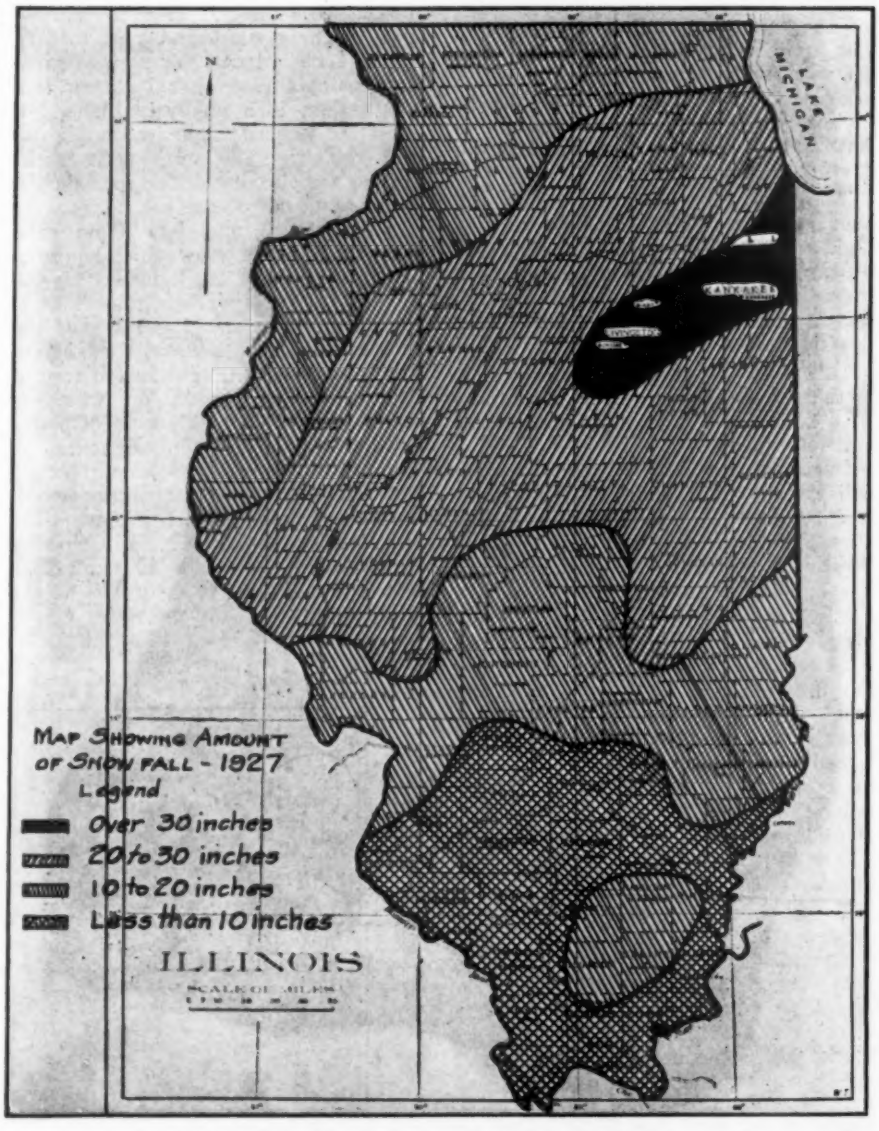
The total number of miles of pavement from which snow was removed was 2,695, and this represented the mileage on which sufficient snow fell to require removal. The total mileage of surfaced roads maintained in 1927 was 5,897 miles. The total cost of removing snow last winter was $184,197.64, including depreciation of equipment, repairs and all overhead charges.

For the coming winter he expects to have available for snow removal work the following equipment: 90 "V" type truck plows, 4 rotary plows, 232 straight blade plows, 9 large "V" type displacement plows for use with 10-ton caterpillar tractors and a miscellaneous number of graders. To operate this equipment he has available 278 trucks of one and one-half to three ton capacity, 35 caterpillar tractors and a sufficient number of light trucks for transporting workmen. In addition to this equipment rental arrangements are being made with private parties for the use of heavy motor equipment to operate plows and graders.

The state has about 3½ miles of snow fence, which will be placed at points where we know from past experience that drifts occur each winter. Each snow removal unit is assigned a different road mileage and instructions are given that the work of snow removal is to begin after 2 in. of snow have accumulated on the road surface, the work to continue until all roads are clear.

In case of unusually severe storms, preference is given to the routes which carry the heaviest traffic and activities are concentrated on these routes until they are open. Oftentimes snow storms are local in character, the area over which heavy snowfalls occur being distinctly limited. As the storm continues the location of the heaviest fall is determined from reports which are received from the district offices, and the work of snow removal is concentrated in these areas.

Reports are telephoned from working forces to each of the nine district offices and these reports are then forwarded to the main office at Springfield, so that we may keep in touch with actual conditions existing in the field. Instructions are given to the men that they must continue without ceasing, both day and night, until all blockades are broken and roads opened for traffic to pass through. The work of widening all lanes is then continued until the pavements are entirely clear.



This Map Shows Normal Snow Fall in State of Illinois

Constructing Better Tar Penetration Macadam

How Best to Do Work On Secondary Roads

By GEORGE E. MARTIN
Consulting Engineer, General Tarvia Dept., The Barrett Co., New York City

THE penetration macadam type of road surface can be built with a small amount of equipment and is a very simple operation. Partly because of these facts some of the work has been very carelessly done and there is a wide variation in the results obtained. Strict attention to a few easily mastered details will produce an excellent riding durable pavement.

In building a new penetration macadam road the subgrade must first be made smooth and solid. Unevenness in the subgrade cannot be removed in the foundation and penetration courses will be carried up into the surface.

First Regrade Surface.—Where an old gravel or macadam road is used as a foundation for a new penetration top, the surface of the old road must first be brought to a smooth and even contour. This can be done by scarifying and re-rolling or by patching the holes with waterbound macadam, penetration macadam or cold patch. If there are many holes scarifying will be cheaper. It has the disadvantage that the foundation will be weakened rather than strengthened as is the case where patching is done. If the old road is thin new metal should be added to it.

The foundation course should present a smooth, even, solid surface for the application of the wearing course stone. An excess of screenings or other loose material on the surface will work up into the penetration course during rolling and prevent the proper interlocking of the stone.

Size of Stone.—The size for the penetration course stone will vary with the quality of the stone. For trap and other hard rocks 1¼ in. to 2½ in. is the best. For the softer limestones a larger size should be used. Uniformity is more important than sizing. Variations such as illustrated should not be permitted since the large flat slabs will not key into place and will usually move under traffic and cause the road surface to break.

Spreading the Stone.—Stone spreaders, such as illustrated, are generally used and give a good account of themselves. A skillful driver can do a good job of spreading out of the back end of a dump truck. A blade grader or one of the modern maintainers will do economical and efficient work in shaping up the stone ahead of the roller. The use of such machinery for this purpose will cut the labor costs and produce a better riding surface than with hand labor.

Rolling the Stone.—Rolling is the most important single operation in the building of penetration macadam road. The roller should be operated at a speed of about 60 feet per minute or about as fast as a man will walk. Faster operation will displace the stone and produce a rough surface. The roller should not be turned abruptly on the loose stone since this action also displaces the stone. Too much rolling on a soft stone will break the stone and fill the voids as shown. The tar binder cannot penetrate and a weak spot is produced. Soft stone should be rolled only once or twice before the tar binder is applied and the main rolling done after that operation. If the

Fig. 1.—Poorly Sized Penetration Stone

Fig. 2.—Spreading the Penetration Stone

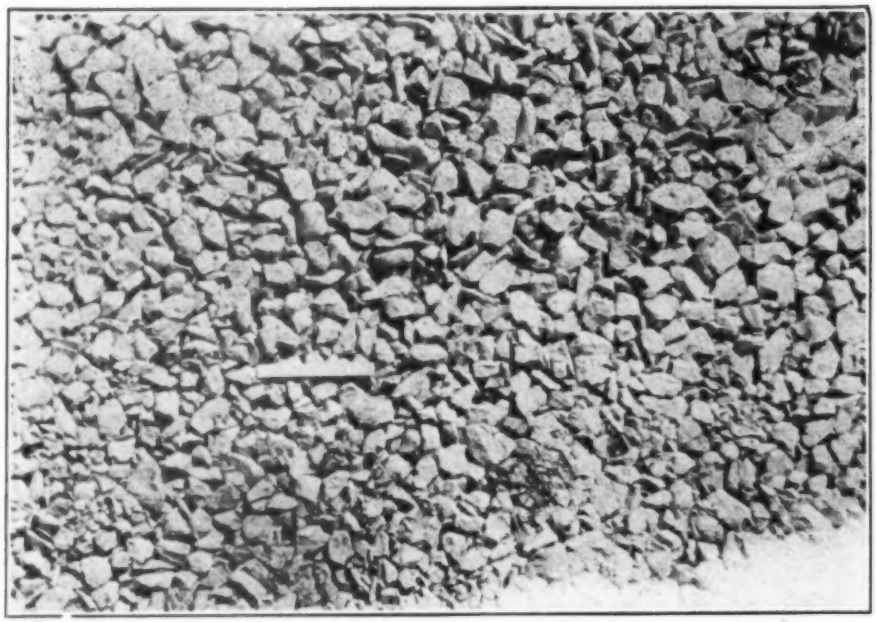


Fig. 3.—Soft Stone Crushed Under the Roller

stone is badly crushed it must be removed and replaced with fresh stone.

Before the first application of tar binder the surface should be inspected for low spots and additional stone added where needed and rolled in place.

Tar Binder.—The tar binder may be applied with hand pouring pots, through a single nozzle from a truck or tank wagon or through a battery of nozzles on a truck. Very little hand work is done now because it is too slow to keep up with the other operations. Uniformity of application is essential and this can be obtained by skillful operation of either the single nozzle or the battery of nozzles. The tar binder should be at a temperature of between 225 deg. and 275 deg. F. at the time of application, near the upper limit for cold weather and small stone, and near the lower limit for hot weather and large stone.

Choke Stone.—Half-inch stone called choke stone is used to fill the surface voids. Just sufficient choke stone should be applied at first to prevent the tarred penetration stone from sticking to the roller wheels. More choke stone is applied during the rolling operation until the surface voids are filled but there should be no loose choke stone over the top of the penetration stone (see illustration). Ruts can be removed by operating the roller alongside the rut and forcing the penetration stone over into it. Do not fill ruts with choke stone. If this is done the rut cannot be removed and a weak spot in the road is formed. The choke stone should be swept around over the surface during the rolling operation so as to have it uniformly distributed. A broom attached to the roller serves the purpose very well.

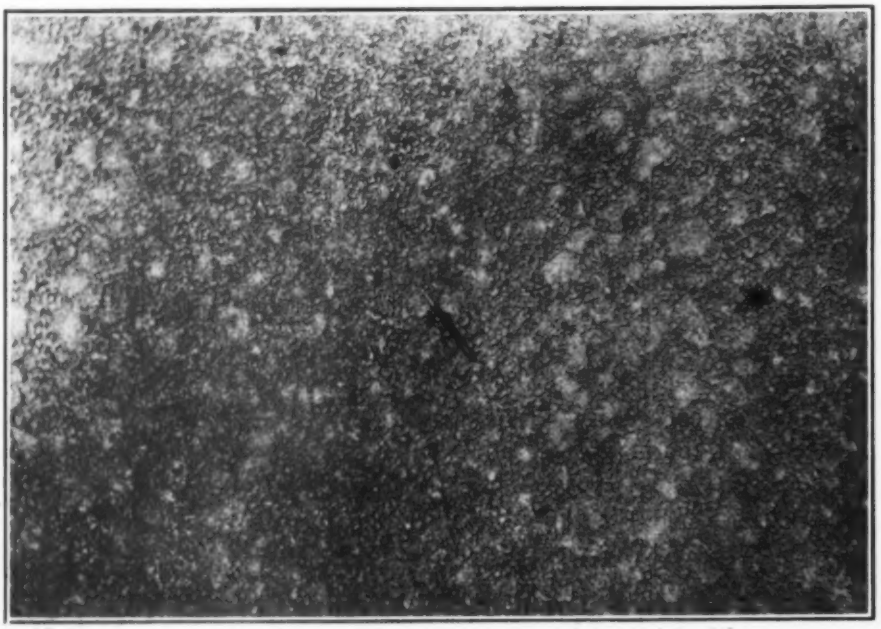


Fig. 4.—Properly Filled Penetration Top Before Sealing

Seal Coat.—The same precautions are necessary in the application of the seal coat as in the application of the penetration binder tar. Cover should be uniformly applied and swept and rolled into the surface.

Thorough and proper rolling will lock the penetration stone together, thus giving stability to the road. Care in the preparation of the subgrade and foundation with proper spreading and rolling of the penetration stone will insure an easy riding road. Correct application and manipulation of the choke stone, seal coat, and cover will produce a tight, impervious, non-skid surface texture.

Safety Campaign of American Road Builders Association

It is estimated that in 1927 there were 26,618 people killed on the highways of the United States. Surely this is sufficiently astounding to warrant the serious consideration of the highway safety problem.

A careful analysis of highway accidents reveals the fact that in an overwhelming majority of cases the blame may be traced to the individual rather than to engineering, mechanical or traffic defects, therefore, the American Road Builders' Association is directing its campaign in an endeavor to reach these users of the streets and highways and have them realize their responsibility in assisting to reduce the enormous number of higway tragedies now existing.

Carefully studied highway safety material is being distributed among the press of the country each week. In addition civic clubs and schools throughout the Nation will be furnished material for lectures and studies in connection with the safety movement. As a result of similar literature sent out in 1927, more than 120,000 people joined the Highway Safety Club of the American Road Builders' Association—the only requirement being personal signature to a pledge to observe courtesy and caution on the highways. The Federal Council of Churches of Christ in America has passed a resolution requesting its members, consisting of more than 25,000 ministers to assist in every possible way the highway safety movement.

The campaign is meeting with phenomenal success and there is no doubt that when the users of the highways adopt the simple creed of courtesy and caution there will be a material reduction in the number of accidents and fatalities on our highways.

General Highway Conditions and Paving

Engineering Commission N. P. B. M. A. Makes Report

WITH a view to obtaining an up-to-date picture of the present status of the highway business, early in 1928 a committee of engineers whose previous training and experience in large capacities qualified them as authorities in the highway field was engaged by the National Paving Brick Manufacturers' Association to make an investigation of the general economic status of the urban and rural highway conditions of the country. The members of the committee were: William H. Connell, Consulting Engineer, Chairman, until recently Chief Executive of the Pennsylvania State Highway Department; Warren R. Neel, Chief State Highway Engineer of Georgia; Perry J. Freeman, Chief Engineer of the Bureau of Specifications and Tests of Allegheny County, Pittsburgh, Pa.; Frederick J. Cellarius, Consulting Engineer, formerly City Engineer of Dayton, O.

The investigation embraced conferences and correspondence with United States Government, state, city, county, borough and township officials in charge of paving throughout the country, a comprehensive study of technical literature on paving, and a general field inspection of typical paving conditions in the Southern, Middle Atlantic, New England and Eastern and Western Central States.

The object of the investigation was to obtain an up-to-date picture of the trend of the highway business in the territory embraced in the survey and also to especially investigate the brick paving situation throughout the country.

The report of this Engineering Commission, which has recently been made public, contains a general discussion of the highway business and the engineering and economic principles that should govern the business; a statement of the standard types of road surfacing and pavements applicable to the different traffic, social, local, climatic and sub-soil conditions throughout the country; also a general discussion of the brick paving situation, results of special tests and investigations and recommendations relative to method of construction and specifications for brick pavements. A synopsis of the general features of the report follows:

Highway Expenditures and Waste.—The report places the total highway expenditures at about $2,000,000,000 a year, and estimates the waste due to incompetent supervision to be about $400,000,000 a year. Considerable stress is placed upon the necessity of employing only trained highway engineers to supervise all highway work so that this waste can be eliminated.

Increase in Higher Type Construction.—The statement is made that the paving programs, including new construction and reconstruction, will grow larger each year in both the centers of population and on rural highways, and due to the constantly increasing traffic, there will be a considerable increase in the higher type construction, particularly on the rural highways.

Discussion of Phases of Highway Business.—The report discusses various phases of the highway business, such as:

Lack of understanding of highway problems by public.

Highway administration.

The Ultimate Highway Transportation System.

How hard-surfaced roads pay for themselves, through savings in motor vehicle operating costs.

Planning highway systems.

Highway transportation investigations.

Location of highways.

Savings in motor vehicle transportation costs due to relocations resulting in shortening the distance.

By-Pass highways.

Ultimate width of highway right-of-way.

Day and night signals.

Elimination of dangerous conditions.

Trend in highway construction.

Standard types of pavements.

Traffic and maintenance data.

Observations of Highway Work.—In this connection, it is stated that the specifications are generally in accordance with present day standards, but that there are entirely too many localities where the specifications are not followed and the work is poor.

Maintenance.—In discussing maintenance, the report states:

"Generally speaking, the maintenance on the state highway systems is of a high standard and the pavements are kept in good condition.

"The average maintenance of the county roads is only fair and in the boroughs and townships it is generally poor.

"The maintenance in some of the cities is very good, while in many others it is poor.

"Lack of adequate maintenance not only to provide smooth riding pavements, but to conserve the investment in pavements, results in an enormous waste of public funds."

Outstanding Causes of Poor Pavements.—The following is stated relative to the outstanding causes of poor pavements:

"Three outstanding causes of poor pavements are: Lack of control over construction, inadequate foundation; lack of proper provision to remedy poor sub-soil conditions.

Control Over Construction.—"Lack of control over construction is the outstanding cause of poor pavements and one that will never be corrected until highway work is divorced from politics. This is a problem for the highway users to solve. The other two are up to the engineers."

Economics of Selection of Types of Construction

In discussing the economics of the selection of types of construction, the following statement is made:

First Cost and Annual Cost.—"It is becoming generally realized that the only consideration first cost should be given in determining upon the selection of pavements is to supply a basic figure from which to determine the annual costs. The items that enter into the costs include interest on the investments and the sinking fund charges for the retirement of the bond issue, or to amortize the cost if paid from current funds, the annual cost for the upkeep of the road under different traffic conditions and the transportation costs or the difference in the cost of operating motor vehicles on different types of road surface.

"Where the pavement is to be subjected to any appreciable amount of traffic comprising heavy loads, high first cost standard pavements will show the least annual cost over a period of years.

"The economic road surfacing or pavement may consist of any type of surfacing from a dirt road to a high quality unit type (vitrified paving brick or stone block) pavement on a concrete foundation."

Financial Advantages of Long Life Pavements.—The report states:

"The inconvenience and additional operating costs incurred by motor vehicles due to reconstruction on a highway carrying considerable traffic, the inconvenience to abutting property and the loss to business interests in built-up localities are so great that the pavements with a very long life and requiring the least amount of repairs are the cheapest when all costs are considered.

"Under such circumstances, a pavement with a long life is justified even though the ultimate cost of the pavement is greater than the cost of two or three less durable pavements for the same period of years."

Vitrified Brick Pavement

The following notes are quoted from the report:

Life of Good Vitrified Paving Brick.—"The life of good paving brick is demonstrated by the old brick pavements throughout the country. An inspection of the brick in these pavements, some of which are 40 years old, proves beyond a doubt that a well manufactured paving brick will not only render satisfactory service under heavy traffic, but due to its long life, it has proved to be an economic pavement under medium traffic. It also has the added advantage of not being affected by the elements or destructive effects due to chemical action. While the traffic was not as great in volume prior to the advent of the automobile, it was harder on bricks because it was narrow, steel-tired traffic, so these old brick pavements have received considerable punishment and still, in innumerable instances, a great percentage of the bricks can be relaid and will render many more years of service. There are comparatively few instances where brick pavements have not been satisfactory where it was due to the brick. The unsatisfactory brick pavements are almost entirely due to four causes:

"First—Poor construction.

"Second—Either no foundation, or one that is inadequate for the traffic.

"Third—Poor sub-soil conditions.

"Fourth—Specification requirements that have proved undesirable, such as the monolithic construction, the grout filler, and thick sand cushion. Sand fillers are also undesirable, except in climates where there is no frost and where vitrified paving brick is used in progressive construction."

There also were instances where bricks that were unsuitable for pavements were used. The closer attention to manufacturing details and the stiffening up of the specifications a number of years ago has taken care of this situation and there is no reason for accepting poor paving bricks.

Life of Vitrified Brick Pavement Under Modern Construction Methods.—"A great many brick pavements from 5 to 15 years old that were constructed on an adequate foundation with an asphalt filler and a thin sand cushion were inspected by this commission. Practically all of these brick pavements constructed in accordance with the approved present-day practice were in first-class condition and had had little or no maintenance and will undoubtedly render a long period of years of traffic service.

"In considering the life of a modern brick pavement, it must be borne in mind that if the brick pavements, many of which were 30 and 35 years old, that were relaid, had been originally laid on an adequate foundation with a thin sand cushion and an asphalt filler, the indications are it would not have been necessary to relay them. This is proved by the many instances of old brick pavements laid on an adequate foundation where a sand or mastic filler was used and in some instances grout fillers that have given upwards of 20 years of service with little or no repairs, and are apparently good for 20 years or more service. The number of years of service and the amount of maintenance will, of course, vary with the amount and character of traffic."

Low Maintenance Cost.—"There are many instances cited elsewhere in this report of brick pavements that have given long years of service with little or no maintenance cost. The rubber-tired traffic and the use of steel chains when necessary will not cause much wear on the brick, so that if all the construction details have been satisfactorily performed, there is little likelihood of any maintenance expense under ordinary conditions for a great many years. Of course, there are extraordinary conditions that are very trying on any pavement, such as an excessive amount of heavily loaded vehicles using steel chains on a street where parking and street railway tracks confine the traffic in either direction to such a narrow width that it is virtually the same as a track."

Analysis of Vitrified Brick Pavements

"This discussion relative to the value of a good paving brick for a pavement is the result of a close analysis of the service rendered by this pavement throughout the country for the last 40 years. Due to the many mistakes that have been made in construction, particularly lack of suitable foundation, thick sand cushions and the grout filler, many of the old pavements do not look good to the layman today. This condition has injured the brick pavement very much, as it naturally would, because the people want a good, smooth-riding pavement."

Reasons for Uneven Surface on Some Old Brick Pavements.—"Many of the old brick pavements are uneven and rough riding; but if one only stops to consider that a great percentage of the bricks are still good for many years of service and if relaid under modern conditions will provide a pavement that will render a long service with little or no maintenance, be smooth riding, easily repaired and have a pleasing appearance.

"The uneven and rough riding pavements are due to two principal causes, one of which is excusable and the other inexcusable.

"First—The very old pavements, or those from 25 to 40 years old, were in many instances laid on the sub-soil because it was felt that this construction would be adequate for the traffic. It must be remembered that while this has probably proved to be an unwise policy, in those days the present traffic was not anticipated, and that there was not any too much known about the suitability of the different sub-soils. For example, in the city of Cleveland there are brick pavements in very good condition that were laid over 20 years ago on a natural sand or gravel sub-soil; while in the same city the pavements that were laid at the same time on a clay sub-soil are rough and uneven and a great many have been reconstructed.

"Second—The inexcusable reason for many poor brick pavements is that in more recent years many brick pavements have been constructed with inadequate foundations just to reduce the cost.

"There was no greater mistake ever made in the highway business than to try to reduce the cost of a brick pavement by saving money on the foundation. First cost should not be the consideration in the selection of a pavement, it should be annual cost over a long period of years."

Specifications and Construction Recommendations

"Only general fundamental recommendations are made in this report relative to specification requirements for materials and construction methods. The several different highway engineering agencies have this matter under consideration, and we are informed new specifications will be prepared very soon covering the points in which there is some difference of opinion at this time. It is recommended, therefore, that the National Paving Brick Manufacturers' Association continue to cooperate with these agencies with a view to formulating a standard specification that will meet with general approval.

"The following general recommendations are made by this commission:

Vitrified Paving Brick.—"Vitrified brick for use in pavements should be thoroughly annealed, tough, durable, non-absorptive and uniformly burned and free from marked laminations. They should conform to the standard tests of the engineering societies and the sizes agreed upon by the Hoover Committee."

Sub-Grade.—"The stability of a pavement depends on the foundation and the local soil conditions must be considered in providing adequate drainage of the sub-grade. A stable sub-grade must be maintained under all weather conditions to insure a durable pavement. If the soil conditions are not favorable to proper drainage, it will be necessary to provide material which will produce satisfactory drainage. The uniformity of a sub-grade vitally affects the durability of a base-course and for that reason great care must be taken to provide for the continuous and uniform compactness throughout the length of the pavement."

Adequate Foundations.—"An adequate foundation for a brick pavement has been very forcibly stressed in this report. This term has been used because it implies that the foundation must be strong enough to support the

pavement under the different traffic, climatic and sub-soil conditions.

"Where the traffic is light in sections where there is no frost, a well-drained sand or gravel sub-soil may serve as an adequate foundation. Old stone, slag and gravel roads are also adequate under certain traffic conditions. Bituminous concrete foundations are also used. Florida lime-rock and chert foundations are used in some of the southern states.

"The generally accepted foundation where there is any appreciable amount of traffic is concrete and this will vary in thickness as well as in the mix used under the different traffic, climatic and sub-soil conditions. There is no such thing as a standard adequate foundation. The facts in each instance should govern the determination of the strength of the foundation, but nothing should be overlooked to insure its being adequate.

"The actual surface of the foundation should be smooth. Variations shown by a 10-ft. straight edge should not exceed ¼ in."

Curb.—"The type of curb must meet the requirements of each particular job. Concrete curb should not be less than 6 in. in width. Steel curbs may be employed and the brick surfacing placed at the edge of the concrete base."

Bedding-Course.—"A sand or granulated slag cushion not exceeding 1 in. and preferably ¾ in. in depth has proved to be the most desirable bedding course."

Laying Brick.—"It is essential that brick should be laid in a manner either by the use of a lug or otherwise which will definitely provide a sufficient space between the bricks for the application of the filler. The filler should fill the space between the bricks from the top to the bottom of the bricks."

The 10-ft. straight edge should be in constant use to obtain smooth and uniform surface and the rolling should be continued until satisfactory results have been accomplished.

Asphalt Filler.—"An asphalt filler has proved to be the most satisfactory and is recommended for general use. Investigations should be made by the Engineering Societies to determine upon a standard specification for a filler best adapted for this purpose.

"It is essential that the temperature of the filler should be such that it will readily fill the space between the bricks. The asphalt filler should not be applied when the bricks are damp or cold. Under such circumstances, provision must be made for heating and drying the pavement."

Measurement of Elastic Strains in Concrete Structures

From the October Technical News Bulletin of the U. S. Bureau of Standards

A test has been made recently to determine the practicability of a method which could be used in field tests of concrete structures for distinguishing between the elastic strains produced by stress and those resulting from changes in temperature and humidity and from plastic flow or yield. In this method small blocks of concrete are cut out of the structure; measurements are made of the elastic recovery which takes place in these blocks as they are relieved from the forces acting when in the mass. The changes in strain accompanying the removal of the blocks were determined readily by means of a hand strain gauge. To facilitate the removal of the blocks, it was suggested that each should be cast in a U-shaped trough or form. The principal object of the test was to determine whether the presence of the form material would appreciably affect the strains in the block and whether the block could be cut without injury to the gauge lines.

A concrete prism 30 by 30 in. in cross section and 36 in. in height was made for the test. The prism contained one removable block near the mid-point of each of the four lateral faces. Each block was in the form of a prism 5x5 in. in cross section and 20 in. in height. One of the forms for shaping the blocks was made of sheet metal about 0.03 in. in thickness. The other three were made of wall board of three different thicknesses. All were given a thin coat of paraffin to prevent bonding with the concrete. Plugs were set in the concrete for use in taking strain gauge readings in three gauge lines on each lateral face of the prism, one gauge line being in the removable block and the other two midway between the edges of the block and the prism.

The prism was placed in a testing machine and a compressive load of 600 lbs./in. applied. After taking strain readings one of the blocks was removed by cutting the concrete along each end of the block. Although this required a cut about 5 in. in length and 5 in. in depth along each end of the block, these were made easily with a small air drill. The load on the prism was then released and strain-gauge readings were made. The same operation was followed in removing another block from the prism.

The results of the tests indicate that the blocks, when separated (except at the ends) from the prism by thin forms, were cut out without a noticeable injury to the gauge lines. It was found, however, that the strain in the block cast into the sheet-steel form was only about 70 per cent of the average strain in the adjacent gauge lines, whereas for the blocks cast into wall board forms the strains were on the average about 30 per cent greater than in the adjacent concrete. These results indicate that some provision should be made when using metal forms to prevent the steel form taking such an appreciable amount of stress as to affect the strain in the concrete block. They show further that wall board, on account of its greater thickness and lack of rigidity, is not a suitable material for such forms. Apparently the method can be made practicable for separating the elastic from the inelastic strains measured in concrete.

Weather Warnings Aid Bridge Contractors

On the border between Texas and Mexico the Rio Grande was at flood stage early this year. At the same time engineers were busy fitting into place the members of a great steel bridge to span the river at Brownsville. The work of erecting the main steel span was at a dangerous stage, due to heavy drift in the river lodging against the false-work piling which supported the span under construction. It was touch and go. An error in judging the dangers and difficulties "might easily have caused the false work to fail and precipitate the entire bridge into the river."

This statement appeared in a letter of appreciation sent by the construction company to the local branch of the Weather Bureau at Brownsville, Tex. Expressing thanks "to those who have been of material assistance to us in the prosecution of our work," the letter mentioned that "we invariably enlist the cooperation of the Weather Bureau when undertaking a construction job, and for obvious reasons." In this bridge job the engineers asked for daily bulletins on the weather of the Rio Grande Valley, and particularly for information as to the river stages. The service by this branch of the United State Department of Agriculture the engineers found "invaluable."

At the critical stage of the work the bureau voluntarily supplemented its usual daily reports with special telegraphic reports from points upriver giving details as to flood conditions. This gave the engineers warning to adjust their operations to cope with the floods that did materialize.

That dangerous conditions did not arise was due, the engineer says, "in no small measure to the assistance of the United States weather reports," adding, "It must be generally true that construction companies throughout the country benefit immeasurably through advance notice of storm and flood conditions."

Minnesota Patrolmen Now Section Men

In order to avoid confusion with law enforcement officers highway patrolmen in Minnesota will be designated as section men, according to an announcement by C. M. Babcock, State Highway Commissioner.

A number of counties in Minnesota employ deputy sheriffs to enforce the traffic laws and they are generally known as highway patrolmen. Many states are adopting the state highway traffic patrol, and people coming from such states have been confused as to the duties of "state highway patrolmen" in Minnesota.

Highway maintenance and law enforcement are two entirely different jobs, each requiring training and experience of an entirely different nature. Many motorists have expected the state "highway patrolmen" to aid in law enforcement at various times, but trying to have maintenance men act as police officers has never been practical.

The change from team patrols to truck units is another reason for the change of name. The name "patrolmen" was generally associated with the men with teams and graders. Hereafter the man responsible for a piece of road will be a "section man," regardless of whether he drives a team, a truck or a power grader. Every mile of road in the state system will be part of a section, with a "section man" responsible for its maintenance. Where teams are used, the "sections" are about seven miles.

The motorized sections will be about 25 miles long. The section man will be employed the year around, though not always on full time in winter. Usually he will have one helper. He will have a truck which will pull a blade grader in summer, push a snow plow in winter, and haul gravel and other materials when needed. In some places, especially in the sparsely settled districts, sections may be longer, up to 60 miles, and the section man will have more than one helper.

"Sections" on paved road generally will be longer than on gravel roads. The section man will make frequent inspections on the pavement and fill cracks if needed. He will make shoulder repairs, cut weeds and clean the roadsides, and keep ditches and drains open. In winter he will be furnished with a snow plow and will keep his section open.

Changing the name from patrolmen to section men will not affect wages or the number of men employed. Motorization is expected slightly to reduce the total number employed.

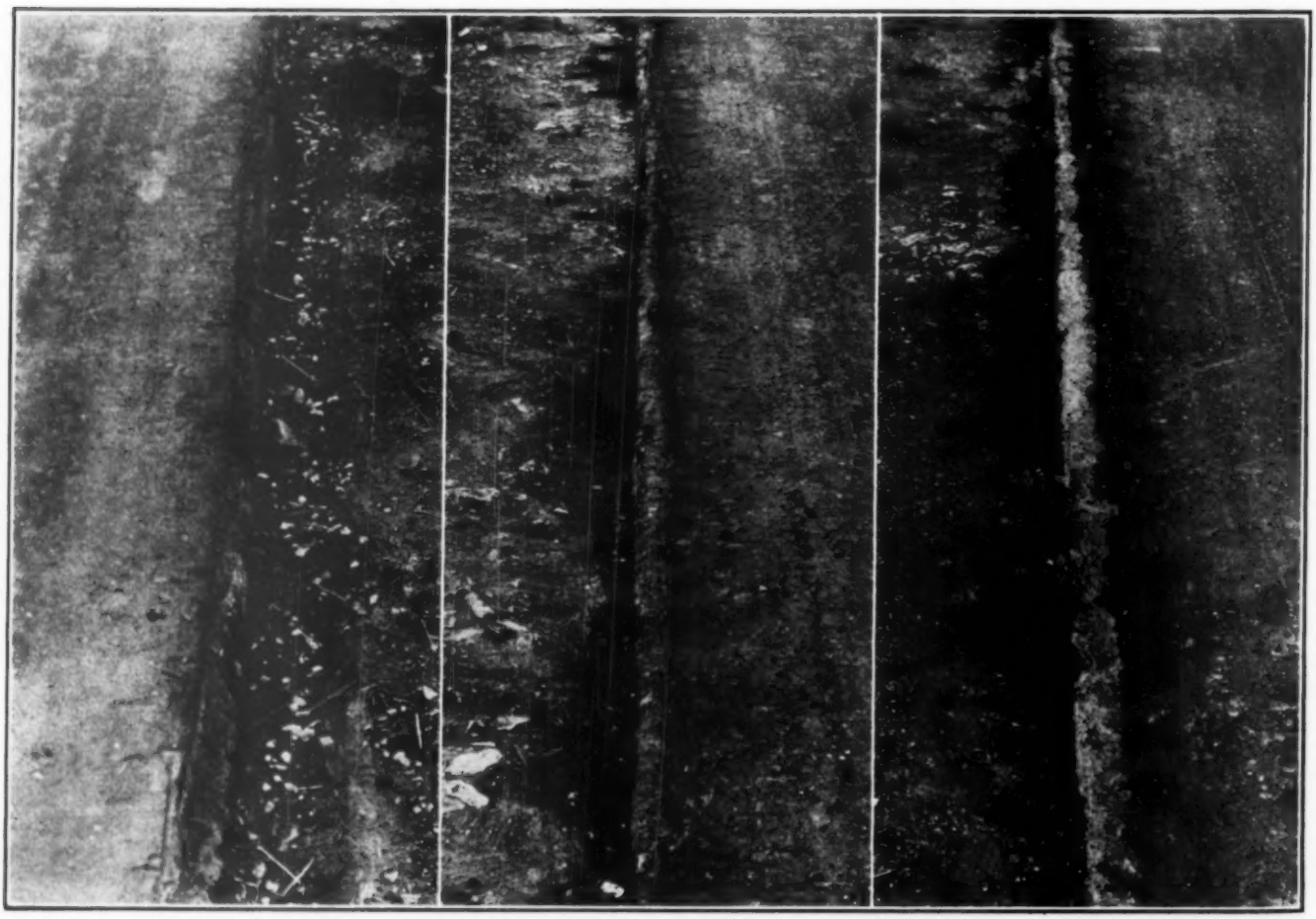
Rock Asphalt Over Disintegrated Concrete Without Marginal Curbs

In October, 1926, it was decided to surface with rock asphalt certain disintegrated sections of the war-time concrete road through the reservation at Camp Knox, Kentucky.

The concrete road was paint coated and surfaced for the full width with 1½ in. compacted Kyrock on one section, surfaced to within 2 in. of the edges on another section, and surfaced to within 4 in. of the edges on another section.

The close-up views taken at the sides on each section show the condition of the edges after 18 months' service.

It is readily seen that the edges of the rock asphalt are today in practically the same condition as the day laid, and that there has been no tendency to shove or crumble, thus indicating that marginal curbs or additional shoulder materials were unnecessary.



The View at the Left Is a Close-up Showing Longitudinal View of Edge of Road Surfaced Full Width with Kyrock. The Middle View Shows the Concrete Surfaced to Within 2 in. of Edge. The Right View Shows the Concrete Surfaced to Within 4 in. of Edge.

Use of Cut-Back Asphalt on State and County Secondary Roads

Method of Maintaining and Salvaging Gravel Roads Used by Wisconsin

By A. T. HAGUE

Asphalt and Road Oil Dept., Standard Oil Co. (Indiana), Chicago, Ill.

IT has been developed in certain sections of Wisconsin and other states that the cost of treating gravel or stone roads can be more than met by the saving resulting from the reduction of patrolling, maintenance, and a gravel loss of at least 200 or 300 cubic yards per mile per year on a heavily traveled road.

Surface treating is a means of saving the present gravel roadway, and building up a wearing surface that will withstand modern traffic. Cut-back asphalt which can successfully be used for surface treating is a paving asphalt cement cut back with a volatile oil. The volatile oil permits the manipulation of a mixture on the roadway by dragging and mixing, with proper equipment, until a perfect surface is secured. The cut-back asphalt will stay in a fluid condition on the roadway after being applied, thereby allowing the gravel to be mixed, dragged and surfaced before the setting time.

It is desirable to make surface treatments to a depth not exceeding 2 or 2½ inches at a time.

A State Job.—Wisconsin State Highway No. 16, Columbia County between Portage and Kilbourn, was surface treated with cut-back asphalt and gravel under the supervision of County Highway Commissioner J. T. Henton and Superintendent of Maintenance B. Ryan. The cut-back asphalt was purchased under the following state specifications:

Asphalt Type "B"—Cut-Back Asphalt Surface Treatment—Cold

Asphalt Type "B" shall be homogeneous, free from water, and shall meet the following requirements:

1. Flash point (open cup), not less than 100 deg. F.
2. Specific viscosity, Engler, 25 deg. C., not more than 110.
3. Separation of asphalt base from distillate flux:

a. Distillate by volume:

To 225 deg. C. (437 deg. F.), not less than 10 per cent.

To 315.5 deg. C. (600 deg. F.), not less than 30 per cent.

To 360 deg. C. (680 deg. F.), not more than 40 per cent.

b. Characteristics of residue from distillation to 360 deg. C.:

Penetration, 25 deg. C., 100 g., 5 sec., not more than 100.

Ductility, 25 deg. C., not less than 30.

Total bitumen soluble in carbon bisulfide, not less than 99 per cent.

Source of Gravel.—Gravel was hauled from local pits at Wyocena. It ranged in size from three-fourths (¾) inch to one-eighth (⅛) inch.

The roadway runs through swamp land and the subsoil consists of a swamp clay loam. The roadway had been graveled for about three years previous to receiving its surface treatment in 1928. It had been well compacted and seasoned under traffic during this time.

Previous to the treatment of this road, maintenance was rather difficult due to the disintegrating of the surface gravel by the abrasive action of traffic resulting in a dust which was a menace to drivers as well as a nuisance to residents along the highway.

Gravel was distributed by trucks in a windrow approximately 6 ft. in width

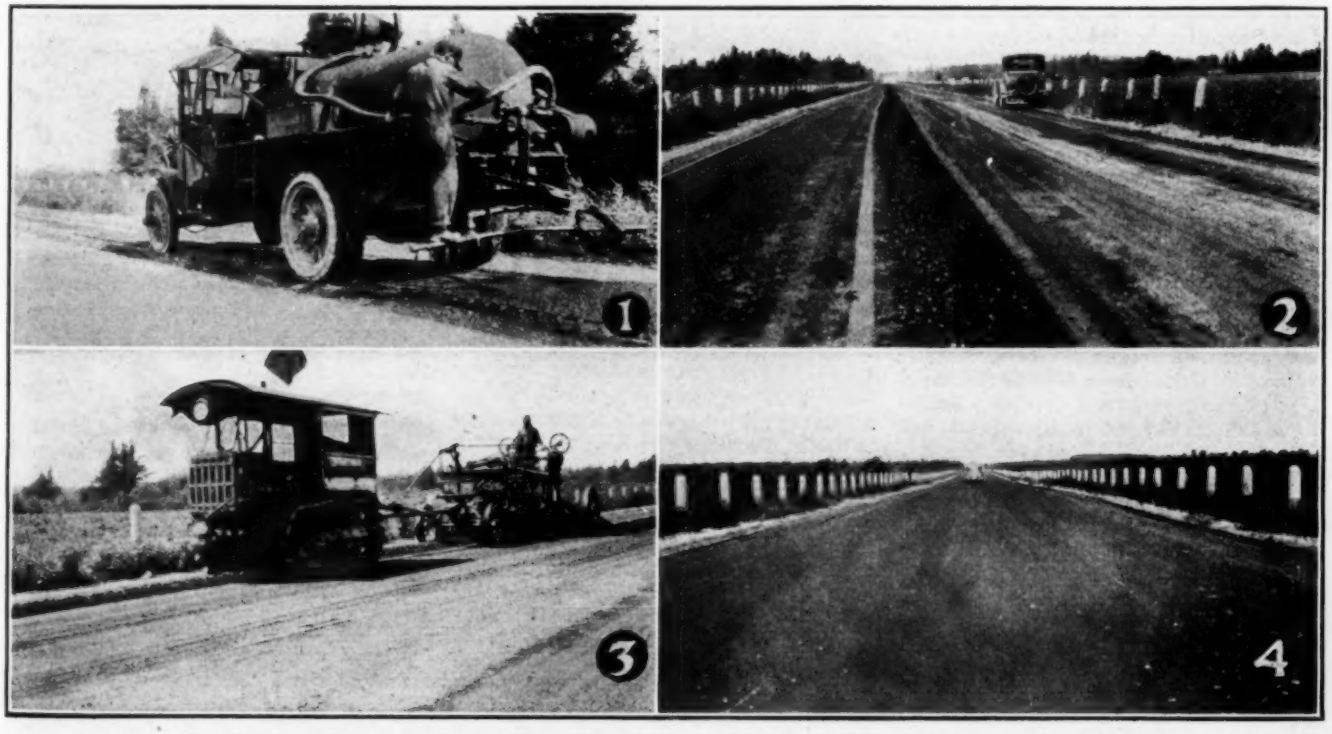


Fig. 1.—Distributor Spreading Asphalt on the Gravel Spread Down Center of the Road. Fig. 2.—The Gravel Spread Down the Center of the Road, Two Applications of Cut-Back Asphalt Have Been Made, and the Two Have Been Well Mixed. Fig. 3.—Blading the Mixture onto the Treated Base. Fig. 4.—View of Roadway One Month After Completion of the Work

along the center of the road, as shown in Fig. 1.

First Application.—An application of cut-back asphalt on the basis of ¼ of a gallon per square yard of finished roadway was applied to this gravel. This gravel and cut-back asphalt was then thoroughly mixed by blading with a road grader. Immediately following this mixing, a second application of cut back asphalt was applied at the rate of ¼ gallon per square yard of finished roadway. Blading was then repeated to thoroughly mix the second application of cut back asphalt and gravel, as shown in Fig. 2.

Second Application.—This mixture was then bladed a little past the center line of the road and the base given an application of ⅛ gallon cut-back asphalt per square yard. The next step was to blade the mixture onto the treated base in order to allow the other half of the road to receive an application of cut-back asphalt, as shown in Fig. 3. The mixture was then evenly spread over the road surface.

Quantity of Materials.—The total quantities of material used per square yard and per mile are as follows:

83 lb. gravel per sq. yd.
0.83 gal. cut-back asphalt per sq. yd.
Or
325 cu. yd. gravel per mile.
9,700 gal. cut-back asphalt per mile.

Equipment and Crew.—The equipment and crew required for the work were as follows:

Five men and one foreman.
Two 750-gal. distributors.
One 12-ft. blade grader.
One 10-ton Caterpillar tractor.

This crew and equipment were capable of completing three-fourths of a mile per day with this type of construction.

Figure No. 4 shows the roadway one month after construction was completed.

75 Mile Toll Road in Colombia

The automobile highway which is being constructed from Cali, Colombia, to the port of Buenaventura was completed during the early part of October as far as Dagua, or 46 kilometers (about 28 miles) from Cali in the direction of Buenaventura. The total length of the highway when completed will be 120 kilometers, or about 75 miles, as compared with the present 108 miles of railroad between Cali and Buenaventura. It is apparent, therefore, that a little more than one-third of the highway has been finished, but it will probably take until December, 1930, to complete the remaining two-thirds since like that which has been done the rest is over rough country.

The estimated total cost of the highway from Cali to Buenaventura is 3,500,000 pesos, which at the present rate of exchange would be about $3,430,000 United States currency.

The highway will be owned by a private company which is furnishing the capital for its construction under contract, but several government agencies have purchased shares in the concern. Tolls are being collected already for the use of motor vehicles of so much of the road as has been opened to the public. For a passenger automobile between Cali and Dagua the charge at the present time is .70 centavos (nearly 69 cents, United States currency). The charges for motor trucks and motor buses range from about .80 centavos to 2.50 pesos, depending upon tonnage capacity.

Pennsylvania Erects 23 Sheds for Storage of Snow Removal Equipment

Preparations for snow removal and storage of equipment during the winter season are being pushed by the Department of Highways of Pennsylvania. Erection of 23 storage sheds of approved fireproof design is the major part of the program, the buildings to be for year-round use and equipped with offices for the maintenance superintendents.

Last year the department cleared 7,110 miles of highways and kept them open for traffic during the heavy snows. More than 800 miles have been added this year so that forces will have about 8,000 miles of roadway to patrol during the coming winter.

While no additions to snow removal equipment are anticipated, the present equipment has been crowding available storage space and in some districts it was necessary to rent space. This item is to be saved by the new buildings, which are going on state-owned ground. All the buildings are standardized, all-metal with fireproof ceiling designed to cut down air space and save heating.

During the open season when all equipment is engaged on road work, the plows will be stored out of the way. All of the automotive equipment is interchangeable for use on snow removal or road work as it is demanded and many parts of the road equipment can be used in snow removal. This enables the department to make year-round use of nearly all the equipment and to store unused machinery without crowding others.

An important feature of the new arrangement will be having equipment within easy reach of the work, whether snow removal or construction. In case of a heavy local snowfall the forces will start from several directions at once before the snow reaches great depth and take up patrols to prevent serious drifting. Each locality will have added assurance that roads will be kept open constantly and none of the equipment will spend long periods traveling to and from the work.

Parking Is Defined by Old Court Opinion

Application of a "Parking Rule" established in 1871 by a court decision rendered in the Montgomery County Court and sustained by the Supreme Court of Pennsylvania is being considered by the Pennsylvania Department of Highways. Although this opinion was given in the days of horse and carriage, rather than "horseless carriages," it is believed the latter come within its scope.

The opinion follows:

"The public possesses, in a public highway, the right of transit and of transit only. The use, by every citizen of public ways, must be a use appropriate to the purposes for which they are intended, that is of transit; with such stoppages as business necessity, accident, or the ordinary exigencies of travel, either in vehicles or on foot, may require. I will illustrate: if one of you, for the purposes of a social visit, place your carriage before a door where it remained in the way while you enjoyed your social intercourse within, this not being such a stoppage as is required by the necessities of business, accident or the exigencies of travel, such occupation of the highway by the carriage would be an obstruction of it, that is, would constitute a nuisance. If however, you drove to a store, and left your wagon in the highway before it, for the time necessary to unload the freight you had hauled for the store, or to load the purchases you had there made, such occupation of the public highway growing out of the business necessities of the occasion, and continued only so long as was reasonably necessary would be lawful. It is upon this general principle that the infamous habit of corner lounging, when not prohibited by special local legislation is illegal. The loungers who occupy the public highway are, while lounging, not using it for the purpose of passage, and are therefore obstructions of the public right of way—that is, nuisances. These are the general principles of the law."

The foregoing is from the charge of the trial judge to the jury. The Supreme Court, after quoting the above, makes this comment:

"The general charge of the learned judge was so lucid in its presentation of the law and facts to the jury in the case that it needs no discussion—and we affirm this case upon the charge, with a single qualification of a matter introduced by way of illustration, viz.: that the carriage of a visitor to the house of a friend left standing on the street is a nuisance. It may become, but is not a nuisance per se, and this we presume is what the learned judge meant, but his language might be misconstrued."

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

To Our Readers

Distributor News is now one month old having appeared once in each of our monthly publications. But, this is a short time in which to become acquainted with 73,000 readers, the number to whom The Gillette Construction Group of magazines goes. Of course, not all of this large number are directly interested in the distributor section, but we hope all of our readers will look it over, for there is bound to be an item from time to time of interest to every one. It is a business asset to know with whom you are competing and Distributor News is the place to become personally acquainted with your friends and competitors.

Up-to-date our distributor friends from the far west seem to be a little ahead of other sections in number of stories telling of their organizations and growth. Distributor News congratulates the Pacific Coast on the business enterprise described in the stories coming our way. We should like to hear from other sections of the country with stories to match those of the west. Send in pictures of your warehouses and little sketches of your sales managers, with photographs if you care to present them.

Take advantage of this department, which is at your service. Create in it such a lively reader interest that it, too, will become a warehouse—not for equipment—but for information of interest to every equipment manufacturer and distributor. Send in your items of personal news, stories of your business growth, questions you would like to have answered or letters which you believe would be of interest to others in your field. Address all communications to Editor, Distributor News, Gillette Publishing Company, 221 East 20th St., Chicago.

Doniphan Lets Dorothy Do It

Miss Dorothy Wright is a prophet not without honor in her own home town. Her occupation is the gravel business, and Doniphan admits she is a "mighty good gravel man."

Miss Wright is but twenty-four years old, but for two and a half years she has been managing a young and growing company with results exceeding anything in its previous record. At the death of her father, T. L. Wright, in April, 1926, she became secretary-treasurer and general manager of the T. L. Wright Lumber Company. Since that time she has made a thorough study of the problems of the business. She has financed and built two new plants and increased the production and sales of sand and gravel from a scant maximum of five to a good average of more than twenty-five cars daily.

Much of the gravel produced at Doniphan goes into the good roads in Arkansas, as this town is situated in Ripley County, Missouri, about 200 miles south of St. Louis and 150 miles north of Little Rock, Ark. Although comparatively new in the gravel industry, the T. L. Wright Lumber Company has been one of the leading business enterprises in its vicinity for a great many years. It was founded by T. L. Wright in 1884. It owns a saw mill at Doniphan and large tracts of timber land, and establishes farms on some of the cut-over timber lands.

About seven or eight years ago Mr. Wright set about developing some of the rich deposits of sand and gravel on his property. These deposits lie in the bed of the Current River, a swift, clear

Dorothy Wright on the Grounds of Her Home at Doniphan

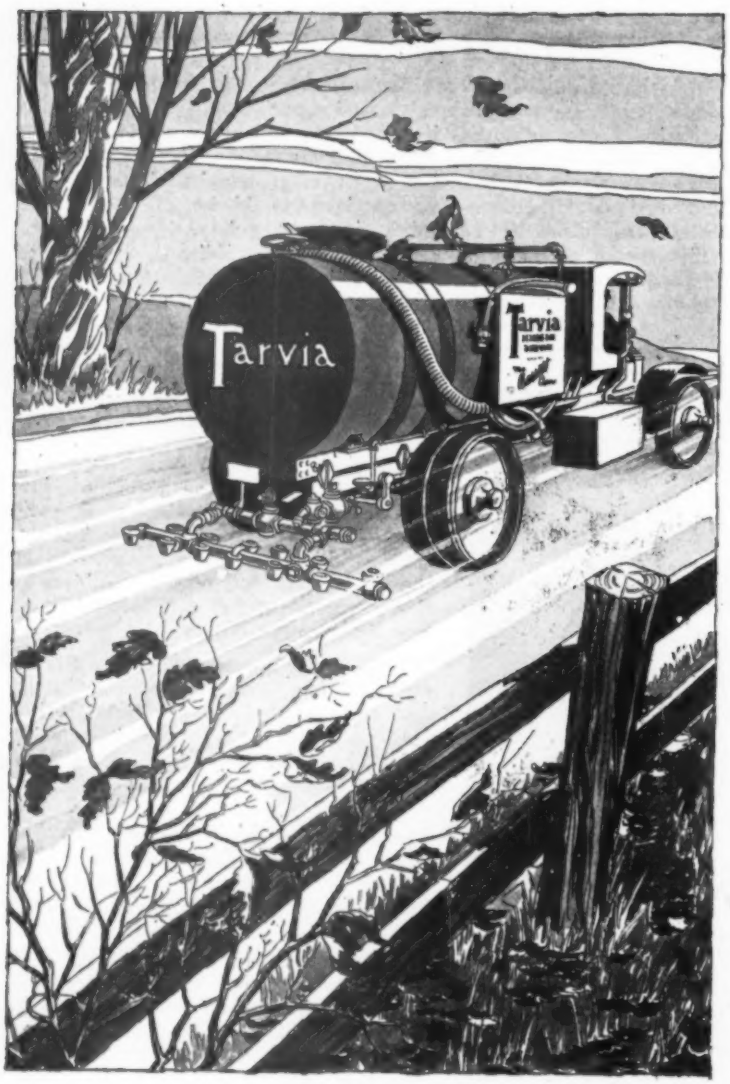
mountain stream coming down from the Ozarks. Several times a year the river rises to a torrent and the raging mountain waters sweep fresh material into the holes where gravel has been dug out, so that the deposit is virtually inexhaustible.

The formulation of a good roads program in Missouri stimulated Mr. Wright to develop this property, but litigation regarding his title delayed the building up of this industry. About the time the way was cleared to develop the deposits in a big way, Mr. T. L. Wright, founder of the company, died. His son, Mr. J. M. Wright, succeeded to the presidency, and his son-in-law became vice-president. But other business interests of these two men left the responsibility for the management of the lumber company on the shoulders of the secretary-treasurer, twenty-two year old Dorothy Wright.

Miss Wright graduated from Stephens College, Columbia, Mo., in 1924, and after that until the time of her father's death held a position in his office in a minor capacity. When Miss Wright took over the management, the production of sand and gravel was low and costs were high. Within three or four months after taking the reins Miss Wright began her work of expansion. To begin with she installed a small screening and washing plant alongside the existing railroad track, so that the products of the plant could be loaded direct to the cars without rehandling, which up to this time had limited the output to from one to five cars a day. She then installed a 13 cu. ft. Sauerman "Junior" cableway to carry material from the river bed, which at that point is over 400 ft. across, direct to the top of the plant.

With these increased facilities for production and costs reduced Miss Wright went after a bigger market, searching not only for the nearby markets for building and road construction, but all of the territory she could reach in competition with other shippers. During the first year she signed up some sizable contracts with the Arkansas Highway Commission, contracted for sand and gravel for a large

It's not too late -



ALTHOUGH the season for road building and repairs is nearly over, you can still complete that urgent job which needs doing before winter sets in.

Barrett's speedy and dependable service will help you.

Take advantage of the few favorable days remaining—and the availability of Tarvia and Barrett distributors—to complete your program.

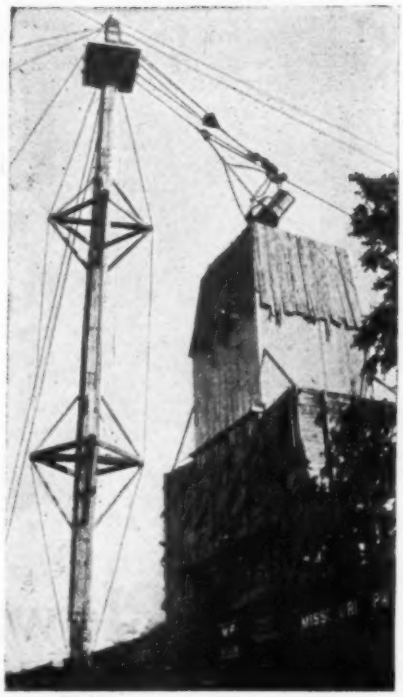
Phone, write or telegraph.

Tarvia
For Road Construction Repair and Maintenance

The Barrett Company

New York	Chicago	Minneapolis	Cleveland	Philadelphia	Birmingham	Boston
St. Louis	Salt Lake City	Syracuse	Providence	Buffalo	Bethlehem	Kansas City
Detroit	Milwaukee	Baltimore	Toledo	Cincinnati	Lebanon	Columbus
Youngstown						Rochester

In Canada:
THE BARRETT COMPANY, Limited: Montreal, Toronto, Winnipeg, Vancouver



View of the T. L. Wright Company's New Plant and Cableway

bridge in Missouri, and readily disposed of all that her new plant could turn out. The increase in business at the end of 1927 necessitated the purchase of a larger Sauerman cableway, a 1½ cu. yd. machine, and last winter built a newer and larger washing and screening plant. This new equipment was ready for production early in 1928, and reports show the Arkansas Highway Commission took about five cars of surfacing gravel, eight cars of concrete gravel and four cars of concrete sand daily, and the Missouri Pacific Railroad took about 200 cars of ballast monthly. A seasoned business man could feel proud of these achievements.

Miss Wright has worked out her own plans of production and sales and has handled the financial problems of the company. She has demonstrated her ability to buy and operate machinery, manage workmen, make contracts for material and see that delivery is made, keep track of costs, keep informed on freight rates—in short, to perform the countless intricate tasks that go with a successful gravel business.

Whoever believes the younger generation is slipping should go to Doniphan and watch Miss Wright demonstrate what a twenty-four year old girl can accomplish when the need arises. Congratulations to Dorothy Wright and her home town!

Celite.—Celite Products Company of 1320 S. Hope St., Los Angeles, Calif., has just issued Bulletin No. 340 on the proper control of workability of concrete.

Personal Mention

Two men, well known in the field of trade publications, announce their withdrawal from editorial work to become associates as merchandising counsel. Colonel Ernest McCullough has resigned as editor and Mr. Edward S. Hanson as managing editor of "Building Age and National Builder." Their activities will include: industrial surveys relating to the adaptability of any product to the field for which it is designed; the compilation of data on the uses of various materials; the estimate of probable demand; the application of materials to new uses; research, etc.

Colonel McCullough will specialize as counsel on production problems, extension of manufacturing facilities, building programs, etc. Mr. Hanson will give consultation on editorial and publishing problems, conducting house organs, etc. Publicity in the engineering, architectural and construction fields will receive their particular attention. They are located in New York City, with offices in Salmon Tower.

Pierce-Arrow Motor Car Company announce the opening of a new salesroom at Broadway and 57th St., New York, in the heart of the city's aristocratic automobile row.

New Lines Wanted

Editor's Note—Distributor News receives from time to time letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment which they would like to represent. Items of this kind will be published and names and addresses furnished interested persons upon request.

A man of many years' experience in the machinery business in the south would like to make a business connection for the sale of road machinery equipment.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

C. F. Pease Company Takes Larger Offices in New York

The New York sales office and display room of the C. F. Pease Company, Chicago, formerly located in the Grand Central Terminal, New York City, has been moved to new quarters, occupying the entire seventh floor, Ashforth Bldg., at 12 East 44th St., New York City. Because of the increased floor space in this new location this office, under the direction of Mr. T. K. Murney, Eastern sales manager, has improved facilities for stock and display of a complete line of "Everything for Blue-Printing" and drafting room furniture. Also an increase in sales personnel has made it possible to more efficiently serve the entire Eastern coast trade.

Manufacturers and Distributors Day at the Road Show

The attention of manufacturers and distributors is called to the importance of being in Cleveland, Jan. 12. The Road Show, which is to formally open on Monday, Jan. 14, has set aside Saturday, Jan. 12, as a day to be given over to distributors and manufacturers. This will afford an opportunity for contact between manufacturers, distributors and representatives previous to the rush occasioned by the attendance of contractors and engineers after the formal opening.

A joint meeting of distributors and manufacturers will be held late in the afternoon of Jan. 12, at which there will be a short program and matters of interest will be discussed. This day, devoted to the interests of distributors and manufacturers, is an innovation for the Road Show, and the directors of the Highway Industries Association have issued a notice urging a good attendance. The announcement further states that all exhibits should be in place by the morning of the 12th.

Buhl Company Soon to Announce New Compressors

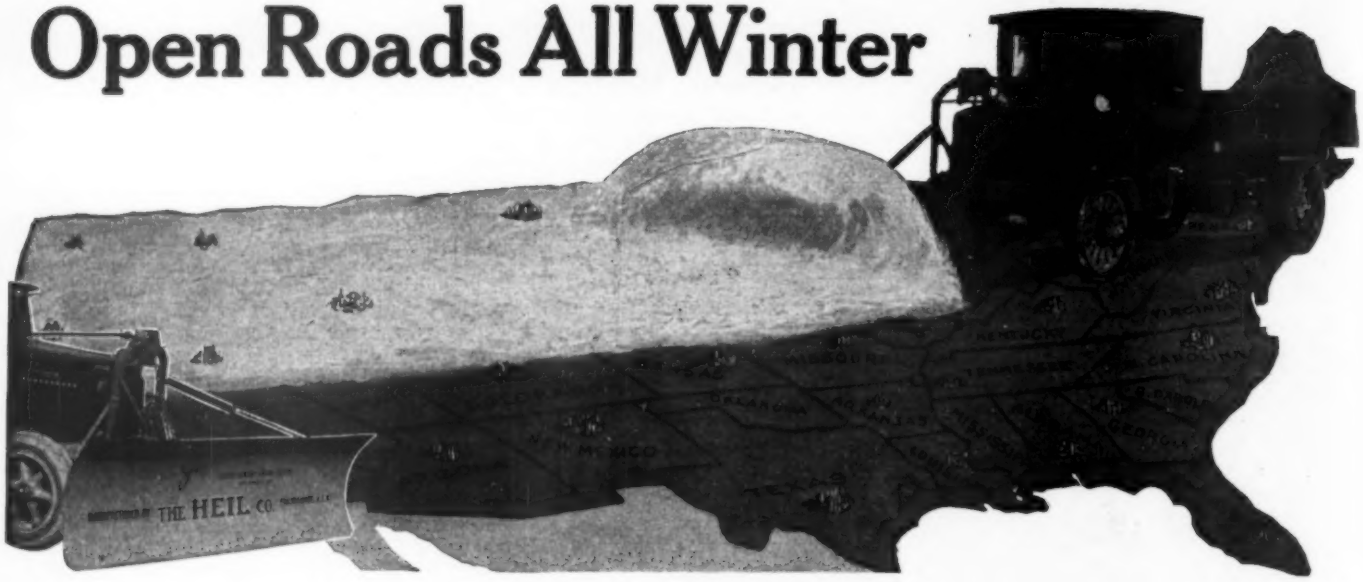
Dealers will be interested in the promised announcement by this company of a new line of larger portable compressors. It is said that many new engineering principles and features heretofore new in compressor construction will be applied. With a refined line of the type C they will be able to present compressors in sizes from 30 to 330 ft. Work on the new line has been going on for the past four years, but it is only now that rumors have become current of the announcement, which it is expected will be made following the Road Show.

The Atlas Portland Cement Company Establishes First Plant in Texas

Plans have been completed for the immediate construction of a plant near Waco, Tex., for the Atlas Portland Cement Company. An announcement has been issued by Mr. John R. Morron, president, that in accordance with the policy of the company to follow the demand for the product and to render service of the highest quality, it is planned to construct and operate at Waco the most modern cement mill possible. Mr. Morron states that the expanding industrial life of Texas and the friendly treatment accorded business interests by the state and its citizens were factors in determining their incorporation of a plant in this state.

An initial annual production of approximately one million barrels per year is anticipated, as this is the first Atlas plant in the state. While the plant is under construction the trade will continue to be supplied from the Kansas mill.

Open Roads All Winter



With Gettelman Hi-Speed Snow Plows

The Plow Blade is offset so as to clear the way for the truck wheels.

Highway commissioners, municipal officials and contractors will find the Gettelman Hi-Speed Snow Plow ideal equipment for solving the highway and street snow removal problem this winter. It is the lightest, fastest and strongest trip blade plow on the market. The City of Milwaukee and Milwaukee County have standardized on Gettelman Hi-Speed Snow Plow equipment, having found through actual experience that the Gettelman plow shows maximum accomplishment with minimum power, is light in weight, has keen cutting ability and is sturdily built to withstand unusual service.

The Gettelman Hi-Speed Snow Plow will operate in dry snow at a speed up to 35 miles per hour. The plow may be easily and quickly installed, and later mounted or removed at will, on any truck of two tons capacity or larger. The scraper blade is 38 inches high and is made in nine and ten-foot lengths.

Mail the coupon below, today, for complete information.

THE HEIL CO.

1138-1150 Montana Avenue Milwaukee, Wisconsin

The Heil Co.,
1138-1150 Montana Avenue, Milwaukee, Wis.

Please send me your Bulletin 183 which contains complete information about the Gettelman Hi-Speed Snow Plow.

Name.....

Firm Name.....

Address.....

The Gettelman Snow Plow Scrapes clean. Here it is in operation on a rough brick pavement.

Trade Publications

The following publications have been received. Copies of booklets mentioned may be secured by writing direct to the manufacturers. In writing mention number of bulletin or name of booklet desired.

Snow Loader.—A very telling folder on snow loaders has been issued by the N. P. Nelson Iron Works, Inc., Passaic, N. J. It not only describes the machine itself, but goes into conditions which must be met and surmounted to effectively solve the snow problem. The results of experience in dealing with this problem in various cities is given. Illustrations show the machine "on the job." Specifications are given for R-5 Special and R-5 Standard. The slogans used are: "Does the work of a hundred men" and "Good enough for the largest city; price within the reach of the smallest."

Diaphragm Power Pumps.—Domestic Engine and Pump Company, Shippensburg, Pa., has issued Bulletin No. 29-D covering the Domestic Diaphragm Power Pumping Units. A new force attachment for use with Model 164 is fully described on page 5. This force attachment is used when in dewatering a trench, manhole pit or other depression, there arises a temporary need to discharge the water handled by the pump. By use of this attachment with Model 164 the water can be discharged either above the location of the pump or horizontally through a line of pipe or hose. The attachment consists of two parts, a "Clamp Device" that is used to lock shut the valve in the diaphragm and a "Gooseneck appearing" device that is equipped with a Domestic double wing guide, air vented, discharge valve. The latter fitting has threaded opening for attaching the discharge hose or pipe and is also tapped for connecting the air chamber and relief valve. A monkey wrench is the only tool needed to install force attachment.

Graders.—In Catalog No. 28, issued by J. D. Adams & Company, of Indianapolis, Ind., Adams Leaning Wheel Graders are fully described and illustrated. This adjustable leaning wheel grader was invented by Mr. J. A. Adams in 1885, and the company bearing his name has been manufacturing and developing graders of this type ever since that time. The catalog contains 56 pages, the subject matter of each page is noted in the table of contents. Graders for all purposes are described.

Belt Conveyor Idlers.—A folder from the Chicago Automatic Conveyor Company, 1845 S. 55th Ave., Chicago, described the result of 14 years' experience in the belt conveyor field.

Steel Buildings.—A new Bulletin No. 1057 has just been received from the Blaw-Knox Company, 603 Farmers' Bank Bldg., Pittsburgh, Pa. We might describe this as a 100 per cent American, as it is setup in red, white and blue. It is handsomely printed on heavy enamel paper, profusely illustrated with cuts, cross-section drawings and specification tables. It is a story of the general use of Blaw-Knox standard one and two-story steel buildings. The use of standard parts makes it a simple matter to change the size or make additions to any building, and such improvements can be contracted for by mail if the building is at a great distance from point of manufacture. The book contains a long list of users of this type of building.

Copper Alloy Steel Sheets.—This is the subject of a new booklet issued by Inland Steel Company, First National Bank Bldg., Chicago. Although this literature is primarily to advertise the product of this company, it includes some very interesting data regarding the corrosion test conducted by the American Society for Testing Materials, as well as a bird's-eye picture of the production of steel from ore to finished product. It is well illustrated, carefully written and is offered as an aid to users of sheet steel and sheet steel products.

Engineering Instruments.—The A. S. Aloe Company of St. Louis in a new 132-page catalog describe many new instruments and modern equipment for the field and the drafting room. The arrangement of this catalog will enable the busy engineers and draftsmen to make a quick and easy selection.

Rock Crushing Equipment.—The Good Roads Machinery Company of Kennett Square, Pa., have issued a very attractive 44-page booklet devoted to rock crushing equipment. Every page is filled with illustrations, cross-sectional drawings and specifications of the products of this company. The booklet is well printed on heavy enamel paper, with an attractive cover of orange and gray.

Cars and Trailers.—Catalog No. 16-A, issued by the Lakewood Engineering Company of Cleveland, gives detailed information and profuse illustrations of narrow gauge cars and track, trailers, trucks and skids. The catalog is well printed on heavy enamel paper, bound in leather finished covers. It contains 54 pages. There is a numerical index of products, as well as an alphabetical index in which the products are grouped in their various classifications.

Electric Traffic Signals.—General Electric Company at Schenectady, N. Y., has just issued Bulletin No. 566-A to supercede No. 566. This bulletin is devoted to Novalux Traffic Signal Systems, embodying traffic signals and their control equipment which possess a flexibility and range of application that enable them to successfully produce any desired traffic flow. The booklet is filled with diagrams, illustrations and specifications of the various types of equipment. The booklet is of the loose leaf type designed for binding with other data.

Electric Heat.—Electric Heat in General Electric Factories is the subject of Bulletin No. 1012 just received from the General Electric Company. This booklet contains full descriptions and illustrations of various types of electrically heated furnaces in use in the General Electric factories, and the reasons for using electric heat.

Electric Ventilation.—American Blower Corporation of Detroit in a folder announce a new rotogravure magazine full of interesting facts and pictures, descriptive of the part electric ventilation plays in the every-day business and social life of America. This magazine is for free distribution.

Incor Concrete.—International Cement Corporation, New York, claims a saving of 760,000 detours by the use of Incor concrete. A new folder issued by this corporation gives many specific examples of the use of this product where traffic would have suffered the greatest inconvenience but for the fact that 24 hours after placing Incor the roads were open for service.

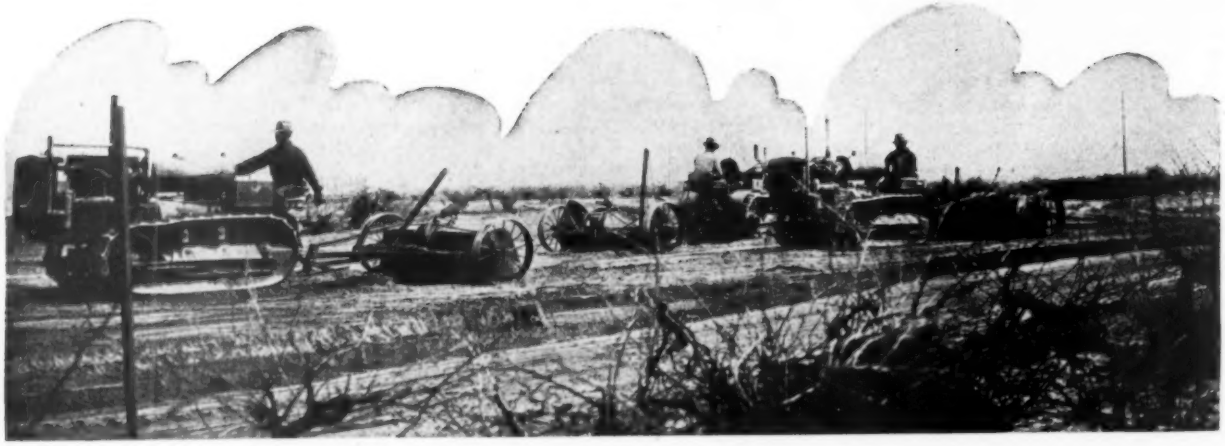
Vibrolithic Pavements.—American Vibrolithic Corporation of Des Moines, Ia., has issued a 20-page booklet on the merits and uses of this product. It is handsomely illustrated and contains detailed information as to service, uniformity, finish, etc. It carries the slogan "Armorplated" Against Wear.

Road Maintenance Equipment.—A short time ago Littleford Bros., 454 E. Pearl St., Cincinnati, O., issued a very handsome booklet, Catalog D, devoted to road and street maintenance equipment. Oil burning kettles, wood and coal burning kettles, tool heaters, sand dryers, portable tool boxes, grout mixers, etc., all properly arranged and clearly indexed in this catalog. Highway officials, supervisors and contractors will find this very interesting. The attractive appearance of the catalog deserves special mention.

Paver.—The Ransome Concrete Machinery Company of Dunellen, N. J., recently announced a new paver—the 13E—which they described in Bulletin No. 120. This machine was designed to fill the need for a fast paver between the Ransome 27-E and 10-E. It is adapted for city paving, alleys, small country roads, sewer work or any job requiring a portable medium sized mixer. Bulletin No. 120 gives complete information regarding this new equipment.

Snow Removal Equipment.—The Good Roads Machinery Company, Inc., of Kennett Square, Pa., have just issued a very attractive catalog devoted entirely to Snow Removal Machinery. The booklet contains 56 pages, with full descriptions and illustrations, and the Index gives a brief description so that model desired may be turned to quickly. Good Roads Machinery Company was established fifty-one years ago, and has branches in several eastern cities, as well as Chicago and Portland, Oregon. In writing for catalog ask for "KSP."

For Earth Moving Equipment



French & Hecht Steel Wheels are used on leading makes of road making and maintenance machines of all kinds:

Graders
Maintainers
Tractors
Trucks
Trailers
Scrapers
Wheel barrows, carts, etc.

The vast experience and facilities of French & Hecht, Inc., enable this Company to design and produce wheels that are mechanically correct for every application.

ATLAS Scrapers are used for many kinds of road work and earth moving jobs. They are efficient, do good work, and are easy to handle. Atlas Scrapers and other leading makes of equipment of this kind use French & Hecht Steel Wheels because the wheels are important factors in the efficient operation of such machines.

Each wheel must be designed for its particular load and function. On certain machines, the wheels must be designed to give maximum traction. They must contribute to light draft. They must be strong enough to withstand continuous service under overloading and severe ground conditions.

French & Hecht Steel-Spoke Wheels are of a distinct type of construction. The method of fastening spokes to hub and tire is a highly developed process that assures a far stronger wheel. This is why French & Hecht wheels are actually about 30% stronger than other wheels of comparable weight.

French & Hecht has made a study of wheel requirements, and design, for all conditions and uses. This specialized service is offered manufacturers. Any information concerning wheels will be gladly supplied. Write.

FRENCH & HECHT, Inc.

Wheel Builders Since 1888

DAVENPORT, IOWA SPRINGFIELD, OHIO

FRENCH & HECHT

STEEL WHEELS

Richards & Hirschfeld, Inc., New York City, export distributors for several large equipment manufacturers, claim the distinction of one of the largest territories covered by any similar organization, as they handle the export trade for their principals for the entire world. They have been making foreign business connections for over twenty years and boast a fine list of selling agents. Some of their agents stock their equipment, although the majority of machines are shipped on order.

Henry W. Peobody & Company, of New York, is another firm of exporters with offices in every corner of the globe. They inform us that American trade publications are of great interest to their foreign clients.

Distributor News

Staley & Morris, Inc., 214 N. 22nd St., Philadelphia, Pa., have been appointed distributors for the eastern Pennsylvania territory for the Erie Machine Shops, Erie, Pa. They will handle the Erie steam and gasoline rollers.

The Motor Power Equipment Company, Ford Road and River Blvd., St. Paul, Minn., has been appointed a distributor for the Trackson Company, Milwaukee, Wis. They will handle all Trackson lines of equipment for the McCormick-Deering industrial tractor. They will also be able to give prompt service on repairs and replacements for Trackson full-crawlers, loaders, shovels, cranes, etc.

The Trackson Company, Milwaukee, Wis., manufacturers of Trackson full-crawlers, loaders, shovels, cranes, etc., announces the appointment of the following distributors who will handle their lines of Trackson equipment in the east: Industrial Tractor Sales Co., Inc., 500 Fallsway, Baltimore, Md.; E. B. Kelly Co., N. Broadway, Box 22, Albany, N. Y.; W. B. May, Inc., 41 Perry St., Buffalo, N. Y.; Truck-Tractor Equipment Co., 460 Neilston St., Columbus, Ohio; Tractor & Equipment Co., 520-522 Passaic Ave., Newark, N. J.; and Service Supply Co., 20th and Venango Sts., Philadelphia, Pa.

Mr. Frank B. Parker, general manager of Briggs & Turivas, Inc., with general offices at Blue Island, Ill., a Chicago suburb, has been made vice-president and general manager. Briggs & Turivas deal in second-hand and retired freight and passenger equipment, and in used ARA freight car parts.

Sullivan Machinery Company is represented in Salt Lake City by the Utah Eastern Iron and Metal Company, and in Sacramento, California, by the Standard Equipment & Supply Co.

The Thew Shovel Co. Increases Sales Force

Due to a 62 per cent increase in the sales of Lorain 75, the Thew Shovel Company has found it necessary to add to their sales force the following representatives, whose names are by no means new to the contracting and construction field:

Mr. J. H. Devine—will be located at the company's Chicago office. Mr. Devine was for several years manager of the Construction Equipment Division of the Smith Booth Usher Co., at their San Francisco office. He comes to the Thew Shovel Company with a full knowledge of their product, having sold equipment of this kind for the Smith Booth Usher Company.

Mr. A. C. McLain—will be attached to the Dallas office, under the direct supervision of Mr. V. L. Wheeler, district manager. Mr. McLain has for the past three years been associated with the White Motor Truck Company of Dallas, Texas.

Mr. D. G. Laurell—with the residence at Alcoa, Tennessee, will be attached to the Atlanta office in a sales capacity for both the Thew Shovel Company and the Universal Crane Company. Mr. Laurell for the past three years has represented the Novo Engine Company in the Southeast and prior to that time was associated with the Wagner Sales Company of Knoxville, Tennessee.

The other three additions to the sales force have been identified with the shovel industry for many years. They will be located as follows:

Mr. H. S. Beale—at the Thew Shovel Company's New York office.

Mr. R. S. Delp—at the Philadelphia office.

Mr. Malcom Jones—at the Chicago office.

Besides this large increase in the number of salesmen, the following distributors will have charge of sales and service in their respective territories:

The Southern Tractor Company, Montgomery, Alabama.

The North Carolina Equipment Co., Raleigh, N. C.

The Hall Perry Machinery Co., Butte, Montana.

The Paragon Supplies, Ltd., Vancouver, B. C., Canada.

The R. G. Moeller Company, Detroit, Mich.

The Jenison Machinery Co., San Francisco, Calif.

(Successors to Smith Booth Usher Co.)

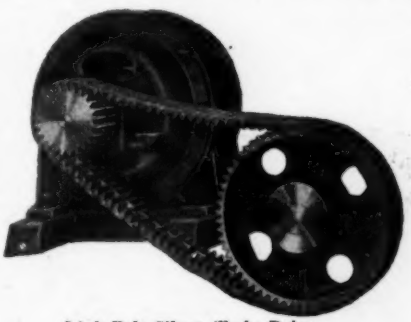
American Tar Products Company announces that their Nashville representative, **Mr. J. M. Lewis**, has changed his address from 3713 Central Avenue to 1708 Villa Place.

Link-Belt S. C. Drives from Stock Now Available Up to 60 H. P.

Link-Belt Company's new silent chain drives from stock book, just published for their trade, evidences the soundness of an idea advanced by that organization some four years ago, when they inaugurated the plan of furnishing silent chain drives from stock. At that time they announced that silent chain drives of ½ to 10 H. P. would be available from stock, as a joint result of standardization and quantity production.

Theretofore, for more than twenty years, the installation of silent chain drives had been strictly an engineering problem. By their plan, they proposed to so simplify the ordering of drives, through the provision of carefully arranged tables, etc., that their customers would be enabled to order direct from stock. In 1926 the range of horsepowers was increased to 15 H. P.

Now, two years later, and only four years after the idea gained its first impetus, the demand for drives from



Link-Belt Silent Chain Drive

stock has made it necessary to increase the range to 60 H. P. According to their latest silent chain publication, Book No. 725, it will be possible to obtain drives as high as 60 H. P., in practically any reduction from 1 to 1 to 7 to 1, for immediate delivery, by distributors in the principal cities of the United States.

The "drives from stock" plan does not, of course, in any way affect the range of horsepowers available in the silent chain engineering drives which this company furnishes to industry in general, in drives up to 1,000 H. P. and over.

Link-Belt Company's production of silent chain drives is entirely concentrated in one plant—the Dodge Works, at 515 N. Holmes Ave., Indianapolis, Ind., of which James S. Watson is manager.

The Newlin Motor Company, distributors for Smith mixers in Kansas City, has organized a separate department for handling the sale of contractors' equipment. The new department will be known as the Industrial Machinery Company.

The New Austin Dual Drive Motor Grader

The new Dual Drive Motor Grader recently announced by the Austin-Western Road Machinery Company of Chicago is said to be an unusually well designed machine.

The four wheel drive on this grader is said to furnish the valuable features of a crawler tread without the disadvantages of high power consumption, excess friction or greatly reduced speed. The entire weight of the McCormick-Deering 10-20 tractor is carried on the four drive wheels rather than on the frame of the grader.

The extra weight on these drive wheels, together with the increased ground contact, gives much greater traction, which for the first time allows the full power of the motor to be utilized. With the Austin Dual Drive, the motor will kill itself in an effort to spin the wheels before they will slip, say the manufacturers.

While the four drive wheels are regularly fitted with 6 in. tires, those who are anxious to obtain maximum service, and especially the ability to get on the job early in the spring or soon after a rain, can obtain 10 in. tires, which provide twice as much bearing surface as it provided on ordinary graders.

The four areas of driving contact make it possible for the Dual Drive Motor Grader to get over soft ground and out of slippery or wet holes that would be quite impossible for the old two-wheel type, the manufacturers claim. The four distinct areas are separate from each other so that if one or two wheels run onto a difficult spot, there will still be two or three wheels left on hard ground to carry the machine through.

The reduced pressure per wheel with the four drive wheels, even though the total weight is greater, by lessening the tendency to get stuck makes it possible to get out on the road sooner after a storm or earlier in the spring than can be done with the two-wheel drive graders.

The front end of the tractor is carried by a spring support on its own drive wheels and axle instead of by the frame of the grader, which is pivotally connected by heavy rocker beams with the rear axle. This gives the tractor flexibility and freedom to move up and down inside the grader frame as uneven road surfaces make such movements necessary, using the rear axle of the tractor as a pivotal point.

The New Austin Dual Drive Motor Grader

With the exception of those mentioned above, and also a new type of blade lifting mechanism, all of the well known Austin features remain unchanged. Among those other features may be mentioned the ball and socket blade raising rod connections, the heavy cast steel circle with its simplified and positive locking device, and either leaning front wheels or an automotive type of steering of special design.

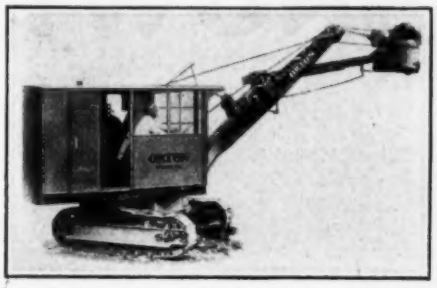
New Orton Shovel Speedy in Operation

One of the recent developments in shovel design is the new Model "A" convertible ⅝-yd. shovel recently brought out by the Orton Crane & Shovel Co., Chicago, Ill. It is said to be an exceptionally fast machine, capable of delivering more than ordinary output. Its light weight, small over-all clearances and high mobility are said to make it particularly suitable for excavating and grading contractors, material yards, industrial plants and similar applications.

Chief among the features of the new Orton Model "A" machine are said to be a well balanced design, the scientific distribution of material, the use of alloy steel for all power shafts and gears, and the extension of cab so that the work can be seen from both sides of the operator's position. These features contribute greatly to speedy operation, and the sturdy construction insures a machine of extraordinary endurance, the manufacturers claim. Strength and rigidity of the base are obtained by building it of rolled plates and shapes which are thoroughly riveted and electric welded. The use of structural steel combines lightness with uniformity of material; there can be no blow-out holes or shrinkage cracks. Electric welding gives the necessary rigidity for supporting shafts and bearings, and for withstanding operating strains.

Flexible crawling treads of the spring type absorb shocks and protect the operating mechanism from undue strains. The springs distribute the weight of the machine uniformly over the treads so that it is not concentrated when the machine travels over uneven ground, logs or other obstructions. The treads are self-cleaning and will not clog with loose dirt or stones, it is said. The Model "A" can also be furnished with road wheels or for mounting on standard auto truck chassis.

All of the power shafts are made of alloy steel, and are turned and ground. Each power shaft is in a horizontal position, and can be removed without interfering with any of the others. Interchangeable phosphor-bronze bushings are provided for all bearings. Gears are made of special heat-treated alloy steel, and all spur gears are cut from solid blanks.



Speedy Operation and Large Output Are Features of the New Orton Model "A" ⅝-Yd. Convertible Shovel

Power is provided by the heavy duty 53 hp. Hercules motor, which is provided with an electric starter as standard equipment.

The Model "A" can be furnished with shovel, crane, dragline, ditcher or skimmer attachment, and can be changed from one to any other in the field in less than two hours.

A feature of the shovel is the positive crowding action, the full power of the engine being transmitted directly to the digging edge of the dipper by the patented gear-driven crowding device. The shipper shaft is driven by a slip friction adjusted to release before the main clutches slip or the engine stalls. In operation, the crowding clutch is thrown in completely, and a constant thrust is maintained on the dipper, the slip friction acting to absorb shocks and jars, and to prevent killing the engine or transmitting undue strains to the power clutch. The entire crowding mechanism is integral with the boom, thus facilitating changes to other attachments.

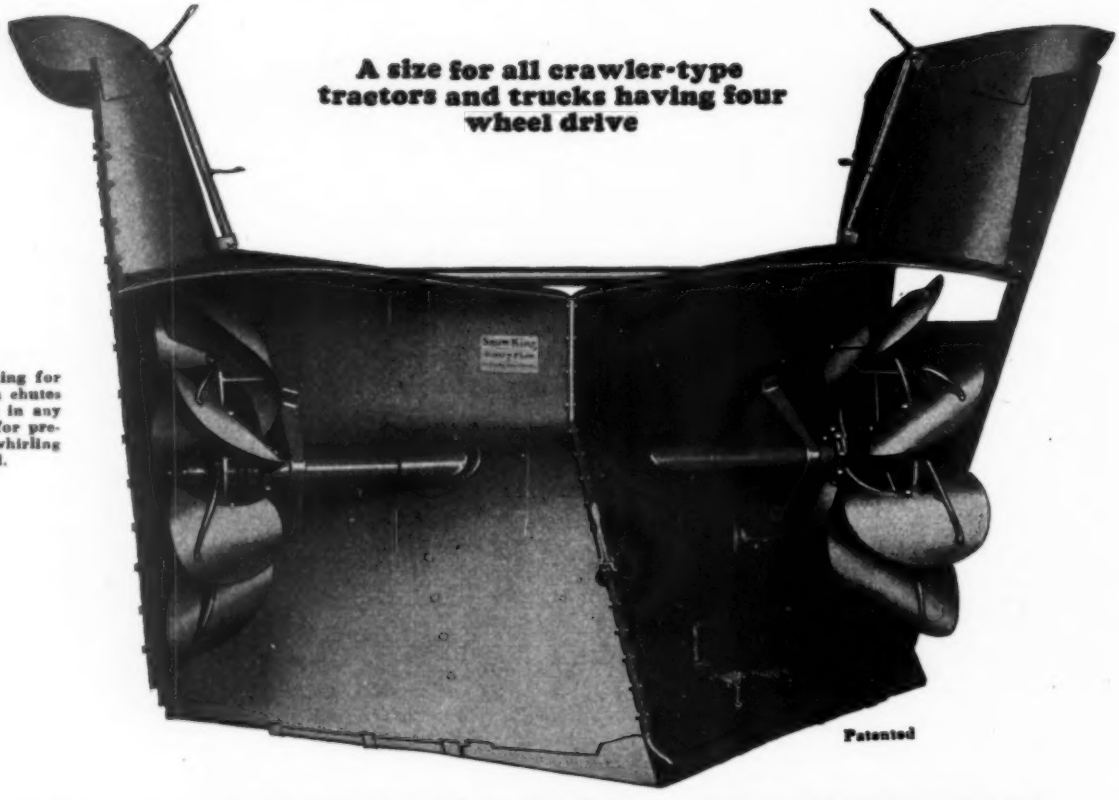
The Model "A" crane has a lifting capacity of 6 tons at a 12-ft. radius, and when equipped with a standard 30-ft. boom, handles a ½-yd. bucket throughout its operating range. Booms 35 or 40 ft. long can be furnished for hook operation.

The patented Orton "T" head on the ditcher attachment gives maximum pull back when the digger stick is nearly horizontal, and minimum pull when the scoop is in a digging position. This arrangement affords great digging power and also serves to snap the scoop back quickly when dumping. Two drums mounted on the boom, one on the top leading to the hoist drum and the other leading to the scoop, eliminate a sheave at the scoop, and give a straight, direct pull, thus securing maximum digging power and depth of cut, and also preserving the cable, it is claimed.

The dragline has a 30-ft., lattice-type boom, and the fair-leader slides so as to give the most direct head possible to the drum, being carried on a bronze-bushed, cast-steel lead sheave, with

SNOW! Are You Ready?

A size for all crawler-type tractors and trucks having four wheel drive



The improved Snow King for 1929 is equipped with chutes for throwing the snow in any direction desired and for preventing wind from whirling snow back on the road.

Only SNOW KING Removes Snow Completely

So thoroughly has Snow King demonstrated its superiority in snow removal that it is today the most widely used snow plow in the world. It is the first choice of men experienced in snow removal operations, because it is the only plow that removes the snow completely.

Highway officials and engineers know that it is not enough merely to push the snow aside and bank it along the edges. It must be completely removed in order to prevent trouble in future snow storms and in Spring maintenance operations. Snow King alone does a complete job! Its sharp-edged mould board breaks up every snow formation—wet, packed, drifted or frozen. Its powerful lateral rotaries whirl the snow up through conveyor chutes and throw it far from the road. Here is true snow removal—far superior to the brute method of pushing and bucking snow aside.

Snow King will keep your roads open this winter at less cost and with less labor—and will do the job better than it can be done in any other way.

Write us today for complete information and prices.

The Rotary Snow Plow Company — Minneapolis

Snow King ©

(Lateral Type)

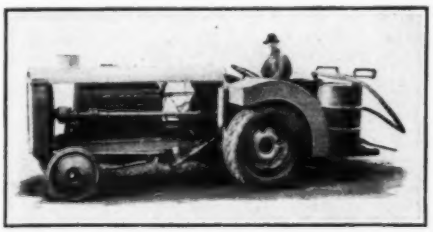
Rotary Plow

guard sheaves properly balanced so as to produce a minimum amount of wear on the cable, it is said. It handles a bucket with a capacity of ½ cu. yd.

The Model "A" skimmer is provided with a steel boom, from which the scoop is suspended by means of bronze-bushed steel rollers. It has an effective length of travel of 11 ft., and the scoop has a capacity of ½ cu. yd., with a width of 30 in., although special widths can be furnished.

Road Oiler on Light Steam Tractor

The enclosed illustration shows what is said to be the only light steam propelled tractor built anywhere in the



The Bryan Road Oiler on Light Steam Tractor

world. It is equipped as a road oiler. An additional pump has been worked out, as shown between the two barrels on the rear view, that gives considerable force in spraying the oil.

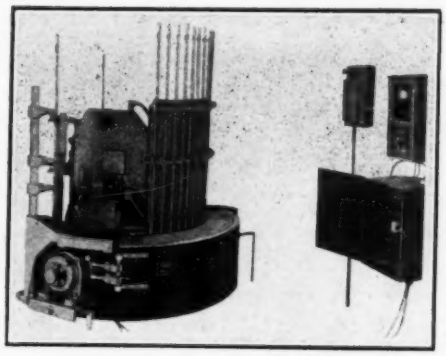
The steam exhaust from the engine goes through the tanks, thinning the oil to any desired consistency and then with the high pressure carried on the boiler the oil can be released with considerable force, driving it straight down into the surface.

This steam tractor road oiler is manufactured by the Bryan Steam Corporation, Peru, Ind.

New Heat Treating Machine for the Shop

The Gilman Manufacturing Company of East Boston, Mass., has recently placed on the market an electric automatic heat treating machine for hardening and tempering automatically, by mechanical and electrical means, the bit end of rock drill steel as used in mining, quarrying and on contract drilling.

The electric furnace in which the drill steels are heated is of the Globar type, consisting of a heating chamber, rectangular in section with a slot extending lengthwise in its top cover, through which the drill steels, suspended on carriers from the circular track of the machine, are inserted.



Heat Treating Machine for Drill Steel

When in the heating chamber the bit end of the steel is heated by radiant heat from the Globars to the exact hardening temperature when it is automatically removed from the furnace, hardened by quenching in a fountain of cold water and then tempered, after which it is automatically ejected from the machine ready for use.

The manufacturers claim that the automatic control mechanism insures the temperature of the drill bit being held within five degrees, plus or minus, from its exact critical range temperature at the instant the drill steel is removed from the furnace for quenching.

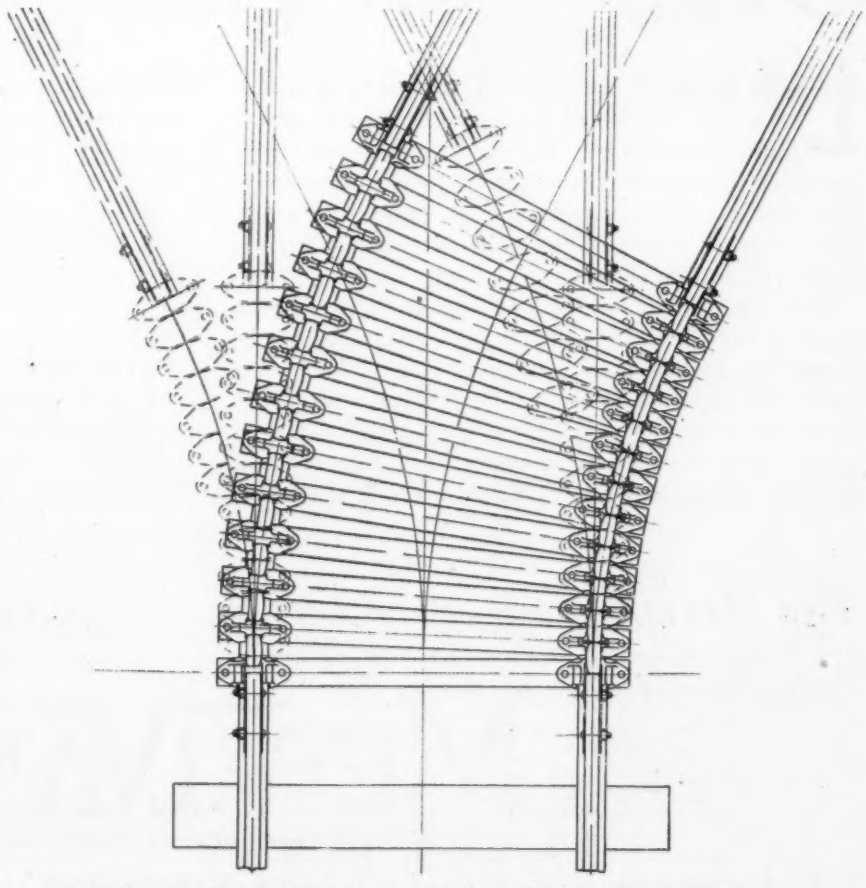
The electric current requirements of the machine are 32 kw. when heat treating drill bits at the rate of one hundred per hour.

It is also claimed that great economies are effected by the use of this machine by removing entirely the personal equation from the operation. On a number of operations the use of the Gilman Automatic Heat Treating Machine has resulted in a decrease of from one-third to one-half in the quantity of drill steels required to perform a given amount of work as compared to previous methods, says the manufacturers.

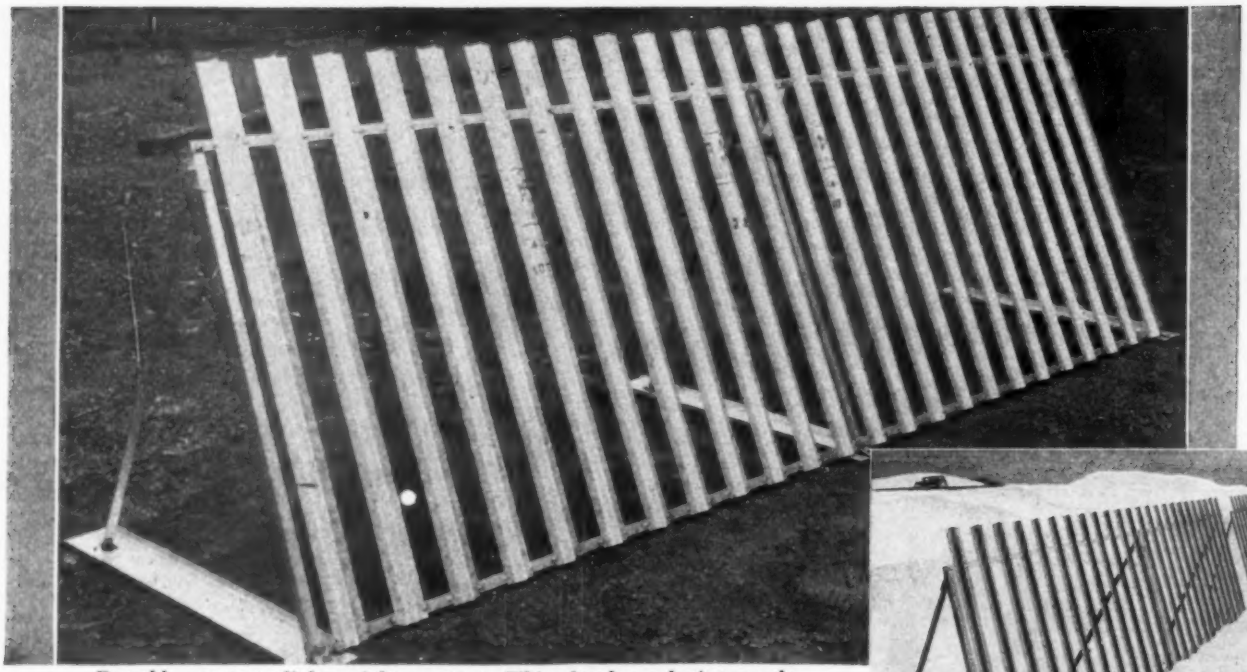
Flexible Rail Increases Shovel Efficiency

Locomotive shovel operations can be more conveniently handled with a single track if the Clarkson Flexible Rail, manufactured by the Illinois Power Shovel Company, Nashville, Ill., is used, say the manufacturers. This device was originally designed to enable a track-mounted machine to clean up a wide room on coal mine work.

The "rail" shown in the illustration is composed of small cast-steel sections with stop ears attached, which rest in chairs mounted on cross ties. Upon moving the track the inside sections contract and the outside lets out, forming a uniform curve.



The Clarkson Flexible Rail That Can Accommodate a Variety of Track Requirements



Portable—no posts, light weight, compact. This also shows the improved base shoe used for sandy or stony locations to insure a rigid position.

Characteristic vane action—it actually stops the snow.

Portable Snow Control for every emergency with

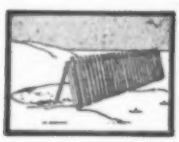
All-Metal Emergency Units

LET the snow fall where it may. If your patrols are Metalvane equipped, you are ready for any storm and your roads will stay *open.* Emergency Units are the only means of snow control that can successfully compete with the unexpected, because they are portable and can be erected instantly even after a freeze. *No posts to drive.*

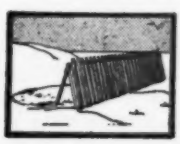
Have a few thousand feet of Metalvane next winter. Store it anywhere, indoors or out. It is completely collapsible to 3 inches in thickness and takes up little space. Place several units where you have had your worst drifts in past years. Have it ready for use, too, at the drift spots you couldn't anticipate. When the first storm hits your section, send out several hundred feet—a truck and a single man will do to erect it. Have him find the "drift spots"—they may be in places least anticipated. You will be surprised at the simplicity of installation—handy collapsible frame work—frost pins sharpened so they will go easily into any soil or right in the snow. No digging out—*no posts to drive* into frozen earth—no angles to set. Come back the next day over the road you had expected to find submerged—actually find it clean as a whistle. One length of Metalvane has frequently accomplished what hundreds of feet of ordinary fence and plows combined had never done before. You'll realize then that a few thousand feet of All-Metal Emergency Units are indispensable in any highway snow-fighting kit.

If you are interested in this Emergency Barrier make sure of your supply by writing today for our Free bulletin, "Economical Snow Control."

THE METALVANE SNOW CONTROL CORPORATION, *Sioux Falls, S. D.*



METALVANE



U. S. and Canadian Patents: 264755, 264756, 267445 and 1345909

THE ALL-METAL EMERGENCY SNOW UNIT

New Blower Outfit for Cleaning Cracks

The Novo Engine Company recently designed and built a new small blower outfit for the city of Lansing, to clean dirt from cracks in the pavement preliminary to pouring tar. This first outfit proved a success, and its use resulted in such worthwhile savings that the blower is now regularly provided to State, County and City Engineering or Highway Departments having charge of road maintenance and repair work.

Mr. Baker, Assistant City Engineer, says that with this outfit one operator does as much as two sweepers and does the work twice as well. By eliminating all dust from the cracks a better bond is made between the tar and the asphalt. In addition, the city of Lansing uses their outfit for blowing water from expansion joints and on many other similar jobs.

The new outfit consists of a Novo

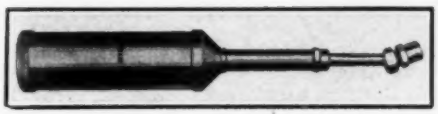
The New Novo Blower Outfit Working on a Street at Lansing, Mich.

Model GU 2 hp. single cylinder, hopper cooled, roller bearing engine direct connected through two to one gearing to a No. 17 Connersville Blower. The complete outfit is mounted on a channel frame truck, with welded tubular spreaders. The Blower has a discharge of 35 cu. ft. per minute. And to provide proper pressure on ordinary garden nozzle is attached to one end of the hose.

Complete information regarding this new outfit can be obtained by writing direct to the Novo Engine Company, Lansing, Mich.

Grease-Rite Grease Gun

Grease-Rite, a new high pressure grease gun, is now being placed on the market by the Grease-Rite Corporation, Cleveland, O., for oiling and greasing all kinds of road machinery and equipment. The change over to the Grease-Rite system is done quite easily without loss of time or shutting down. The conventional grease cup is replaced with a special dustproof fitting which is filled from time to time with lubricant under high pressure from the gun. Under this system much better oiling



The Grease-Rite, a New Grease Gun for Contractors' Equipment

is attained, with repairs and replacements consequently being required less frequently, according to the manufacturers.

The gun is first loaded with the lubricant by removing the rear cap and filling the barrel. The nose of the gun is then slipped over the fitting of the part to be oiled. An ingenious nozzle construction has a contracting steel thimble which tightly hugs the body of the fitting when pressure to the lubricant is applied and which instantly releases when the pressure stops.

The gun is operated by pushing the barrel forward. The desired pressure and volume can be regulated by simply pushing a long or short stroke. A special valve arrangement prevents air locks from interfering with the uniform flow through the nozzle, it is said.

The gun is a self contained unit, very convenient in close quarters and inaccessible places. It is light weight, clean to handle and saves considerable time. It is made of the best materials and well put together, according to the manufacturers' claims.

An Effective Snow Plow for Heavy Work

A photograph on this page shows the Wright snow plow in action on Crater Lake Highway, in Crater Lake National Park, Oregon. It is of the rotary-tractor type, manufactured by Paul Wright, 839 E. Jackson St., Medford, Ore.

The snow shown in the picture was 5 ft. deep, with 37 per cent water, and some ice. It was removed from the highway after being in place all winter, and was packed so hard that a man could walk on it without leaving a track, it was said.

The plow cut through this snow at the rate of 30 cu. yd. per minute, making a cut through a drift or a side bank cut at the same rate, according to the manufacturer.

A New Portable Tool Box

Littleford Bros. of Cincinnati, O., have recently placed on the market a portable tool box mounted on a two wheel trailer. It is shown in the accompanying illustration. This unit should be a very convenient one for contractors and road construction and repair gangs, or wherever tools are to be transported from place to place and where safe storage is necessary.

The box is 45 in. wide, 8 ft. long, 20 in. high at the sides and 25 in. high at the center. A large shelf running through the center the full length of the box provides a convenient place for small tools and equipment. Both covers are hinged and equipped for padlocking.

Box is mounted on the Littleford standard 2½ ton trailer chassis, which is built for high speed traveling. Wheels have 32x5 in. solid rubber tires and ride on Timken roller bearings. Chassis has semi-elliptical springs and

The New Tool Box Announced by Littleford

is provided with front and rear drop legs for holding box in horizontal position when stationary.

Anyone interested in a unit such as this can get full details by writing to Littleford Bros., Cincinnati, O.

The Wright Rotary Snow Plow in Action in Crater Lake National Park, Ore.

Breaking Winter's Grip

DEEP snow-drifts of winter fade away before the powerful attack of the Trackson McCormick-Deering. Light snow falls are cleared with a speed that insures continuous transportation.

Rugged enough to buck through the heavy banks—dependable under the most severe weather and ground conditions — amazingly economical in operation — this Master Crawler-Tractor pays direct returns to the community by protecting trade and traffic.

With the frost gone, the Trackson is ready for road building, maintenance and construction work. Highway officials find it indispensable for superlative service the year 'round.

Let us help you solve this winter problem. Write for further particulars NOW.

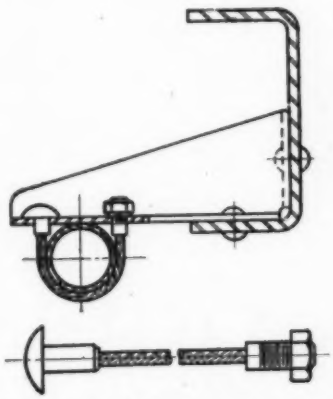
Trackson Company
FULL-CRAWLERS & TRACTOR EQUIPMENT
533 CLINTON ST. MILWAUKEE, WIS.

New Drive for Sand Pumps

The Climax Engineering Company, of Clinton, Iowa, offers a unique drive for sand pumps where it is not advisable to direct connect the engine to the pump.

One installation has been made using Climax Model R4U, 6 in. x 7 in., 85 H. P. engine, connected to a 6 in. sand pump with a special drive. This drive is taken from the engine by a Twin Disc Inclosed Clutch and through a Texrope Drive which furnishes the necessary speed reductions between the engine and the pump, permitting the engine to operate at 950 RPM and the pump at 625 RPM. Provision is also made for driving a service or priming pump from the front end of the engine.

In a recent test the capacity of the unit delivered much in excess of 1,000



New Drive for Sand Pumps Announced by Climax Engineering

gal. of clear water per minute, or more than 30 cu. yd. of solids, to a maximum height of 60 ft.

This oufit has proved to be a very popular type for contractors and has an attractive field for installation on barrel type dredges to pump sand and gravel from the bottom of a river or lake to a sorting or screening bin on the shore or at the top of a hill.

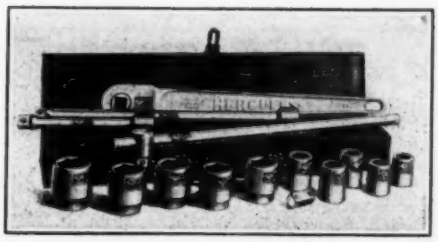
Its easy portability and extreme light weight have appealed immensely to the contractor or operator engaged in this business.

The engine may be equipped with an electric starting and lighting outfit and of course cooperates from an ordinary drum by means of a vacuum tank and flexible tubing. The engine may be supplied with or without a radiator.

New Bonney-Hercules Socket Wrench Set

A new heavy duty set of socket wrenches, made of chrome vanadium steel, is announced by the Bonney Forge & Tool Works, Allentown, Pa.

The set is composed of 10 sockets, running in size from 15/16 in. to 1⅝ in. opening. It is said to be especially designed for extremely hard service and



View of Socket Wrench Set Announced by Bonney Forge & Tool Works

to be so proportioned that although light in weight it is said to have very heavy reserve strength factor. The set consists of 10 sockets, ratchet handle and a short and long extension sliding "T" handle. Each set is packed in a substantial black enameled carrying case.

Koehring to Bring Out New Paver

The Koehring Company, Milwaukee, Wis., manufacturers of pavers, mixers, gasoline shovels, cranes and draglines, has discontinued the manufacture and sale of its present model 27E paver.

A new and greater Koehring 27E heavy duty paver—new in principle as well as new in design; greater in that it embodies the far-seeing conception of today's modern paving mixer requirements—will shortly take its place in the field as the finest paving unit produced by this manufacturer.

Koehring sales representatives stand ready to see that every need of the paving contractor is taken care of should his work require a paving mixer between this time and the first of the year.

Salt Water Injures Roads

Secretary of Highways James Lyall Stuart of Pennsylvania has announced that the operation of ice cream trucks and similar vehicles, dripping salt water upon pavements of Pennsylvania highways, will not be permitted and that, unless such trucks are so constructed to prevent dripping, the owners will be prosecuted for violation of Section 818-C of the Motor Vehicle Code.

Laboratory tests of the Department of Highways are stated to have demonstrated that common salt has a deleterious effect upon concrete and highway officials have taken this action to prevent deterioration through the dripping of salt water from ice cream trucks or other vehicles carrying salt water. Section 818-C of the Code provides that "no vehicle shall be driven or moved on any highway unless such vehicle is so constructed or loaded as to prevent the contents from dropping, sifting, leaking or otherwise escaping therefrom." A penalty of $10 fine or not more than five days' imprisonment is provided in case of conviction for violation.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUG. 24, 1912,

Of Roads and Streets, published monthly, at Hammond, Indiana, for Oct. 1, 1928.

State of Illinois } ss.
County of Cook }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. S. Gillette, who, having been duly sworn according to law, deposes and says that he is the Business Manager of Roads and Streets and that the following is, to the best of his the ownership, management (and if a daily paper, the circulation), etc., the aforeknowledge and belief, a true statement of said publication for the date shown in the above caption, required by the Act of Aug. 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are:

Publisher—Gillette Publishing Company, 221 East 20th St., Chicago, Ill.

Editor—C. T. Murray, 221 East 20th St., Chicago, Ill.

Managing Editor—H. P. Gillette, 221 East 20th St., Chicago, Ill.

Business Manager—E. S. Gillette, 221 East 20th St., Chicago, Ill.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Gillette Publishing Company, 221 East 20th St., Chicago, Ill.

H. P. Gillette, 221 East 20th St., Chicago, Ill.
E. S. Gillette, 221 East 20th St., Chicago, Ill.
Mrs. R. W. Hume, 303 S. Stone Ave., LaGrange, Ill.

Winifred Gillette, 717 Bonita Drive, So. Pasadena, Calif.

Commonwealth Title Ins. & Trust Co., Chestnut and 12th Sts., Philadelphia, Pa.

Louise Forsythe, 13 E. Windermere Terrace, Lansdowne, Pa.

LaVerne Louer Hellyer, Ambassador Hotel, Chicago, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholders or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

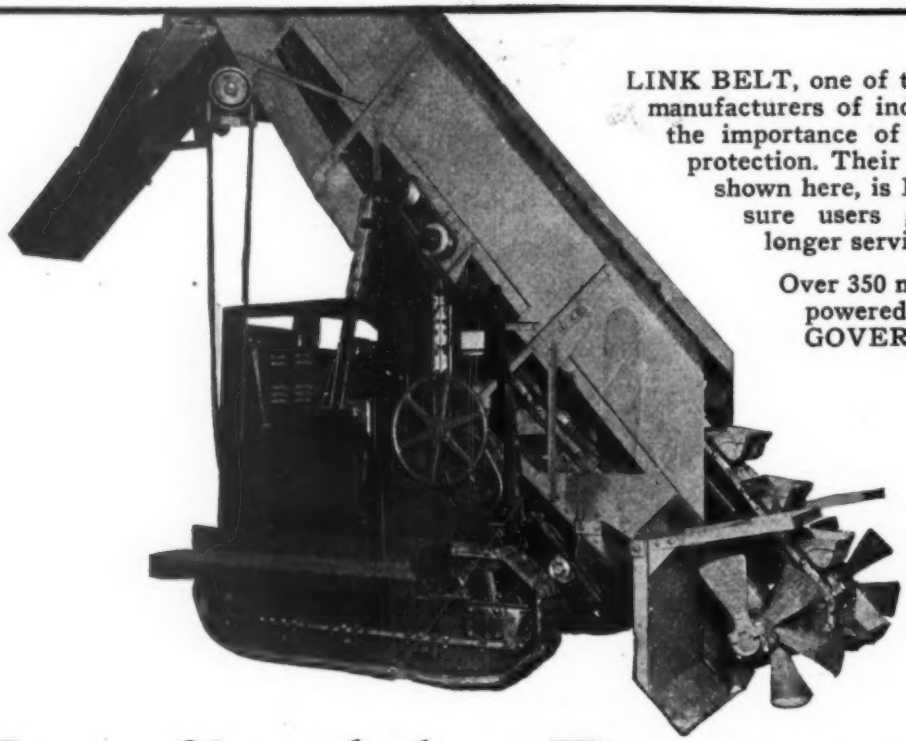
5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is..... (This information is required from daily publications only.)

E. S. GILLETTE,
(Signature of Business Manager.)

Sworn to and subscribed before me this 29th day of September, 1928.

KITTIE C. WOULFE,
(Seal) Notary Public.
(My commission expires Feb. 9, 1930.)

Ungoverned Power Destroys Even the Most Rugged Machine



LINK BELT, one of the country's outstanding manufacturers of industrial equipment, know the importance of PIERCE GOVERNOR protection. Their Grizzly Crawler Loader, shown here, is PIERCE protected to assure users greater production and longer service at a lower cost.

Over 350 manufacturers of gasoline powered equipment use PIERCE GOVERNORS.

Profitable Protection!

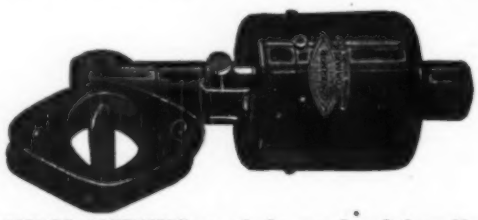
Protecting your power engines against the ravages of racing, stalling and vibration is the sure, easy road to bigger production, lower operating costs and greater profits!

PIERCE GOVERNORS on your power engines assure a smooth, uniform flow of power to meet every load—no matter how wide or sudden the variation. No stalling when the load is applied—no racing when it is released!

PIERCE GOVERNORS protect every moving part of your machines—keeping them out of the repair shop and on the job. They cut fuel and operating costs, save big repair bills, increase efficiency and prolong engine life 200% to 400%.

That's profitable protection for you!

Let us show you in detail what PIERCE GOVERNORS have done for other operators — and what they will do for YOU. Send for Booklet No. 14.



PIERCE GOVERNORS are simple, rugged, and thoroughly dependable. Will last a lifetime. Fully Guaranteed.

We will exhibit at the 1929 Road Show, Cleveland, Ohio

THE PIERCE GOVERNOR COMPANY, Anderson, Indiana

World's Largest Governor Builders

Pierce Governors

For Automatic Speed Control